SEVENTY-SIXTH YEAR

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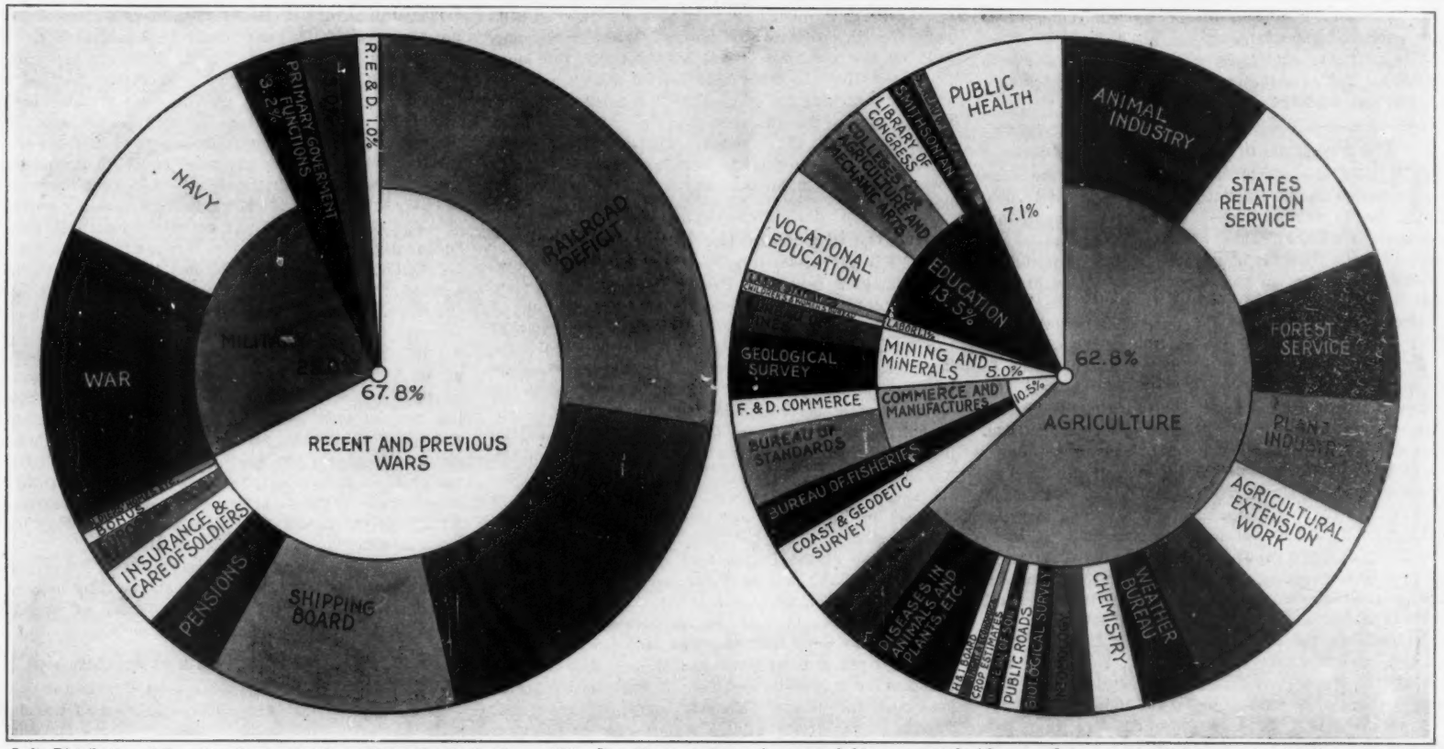

Left: Distribution of the entire Governmental expeditures for the fiscal year 1920. Over 92 per cent goes for war and things connected with war; a bare one per cent for research, education and development—which gets so small a share, in fact, that there is not room to label it in full. *Right:* The $57,000,000 constituting the one per cent of our national budget allotted to this worthy cause of promoting the public knowledge is distributed among the various fields as here indicated.

A graphic demonstration of how the Federal Government spends its money in the course of a year

Where Uncle Sam's Income Goes

By G. H. Dacy

OUR national budget for the recent fiscal year, which ended July 1, aggregated $5,686,005,706. Of this vast appropriation only about one per cent, or $57,093,661 was devoted to research, educational and developmental activities. This money was used by the national Department of Agriculture, Geological Survey, Bureau of Mine, Coast and Geodetic Survey, Bureau of Standards, Bureau of Fisheries, Bureau of Foreign and Domestic Commerce, Bureau of Labor Statistics, Women and Children's Bureau, Vocational Education, State Colleges of Agriculture and Mechanical Arts, Library of Congress, Smithsonian Institution and the Public Health Service.

On the basis of a population of 110,000,000 people this total budget means the expenditure of $50 per capita as compared with an expenditure of only fifty cents a year per capita for research, investigational and educational activities. Of the total government appropriation for this year, 67.8 per cent was devoted to paying off a portion of the indebtedness which has obtained from recent and previous wars. This included interest on the public debt, railroad deficit, the maintenance of the Shipping Board, European food relief, soldiers' homes, bonuses, insurance and care of soldiers and pensions. It took 25 per cent of the gross funds to maintain the military enterprises of Uncle Sam; 3.2 per cent of the appropriation was devoted to the maintenance and operation of primary government functions such as Congress, the Executive, the Federal courts and similar national projects while another 3 per cent was used in supporting public works, including rivers and harbors, public buildings, reclamation service, post roads, national parks and the railway in Alaska.

The outstanding feature about the annual congressional appropriations is that only one per cent is devoted to promote scientific research, to increase production and to intensify efficiency, to develop wealth, to promote public health and to conserve our national resources. To the layman who carefully studies these figures it appears that Congress practices parsimony and economy backside forward when it minimizes the scientific and developmental funds. It is largely through these agencies that the wealth and financial resources of the country at large are increased. To impede their maximum development and operation is to curtail the potential productivity of many of the industries and allied activities.

The appropriation budget for the next fiscal year is drastically curtailed as concerns the funds made available for research and investigational enterprises. Instead of cutting the appropriations for the government enterprises which ordinarily exhaust at least 99 per cent of the total funds Congress carved away at the moneys destined for scientific research to the extent that it will be necessary to abandon much important investigational work. For example, the national Department of Agriculture will have to give up more than 65 lines of experimentation which previously it has been engaged in. Much of this work is of a character which demands consecutive continuation year after year for permanently worth-while results.

About 62 per cent of the government funds appropriated for research and investigational operations are devoted to the work of the national Department of Agriculture. Agriculture is the most important industry of the nation and farming and animal products raised in the United States are worth at least $25,000,000,000 a year. It is of fundamental importance to city residents that agricultural production be maintained and increased with the relative growth of population. The Agricultural Department works with such ends in view: to increase production, to keep food prices within the reach of the masses, to promote the interest of the farmer in his work and to improve rural living conditions and make life in the country more pleasant and attractive. It is spending about $1.50 for every $1,000 of value of agricultural and animal products and, without question, the results achieved pay many times the cost of the work.

The investigational activities of the other government departments engaged in scientific research are almost as valuable to the country at large although not so extensive as those of the Federal farming scientists. Excluding food products, tobacco and liquors, the annual value of manufactured products in this country, over and above the value of the raw materials entering into them is approximately $12,000,000,000. Last year the funds available for the investigations of the Bureau of Standards only admitted of the national scientists spending $.15 per $1,000 of manufactured products in all its work and only one-half of this sum was devoted to work which promoted the development of such manufacturing enterprises.

The other national agencies referred to above have operated under similar handicap, due to similar financial shortages. Unless scientific research is to decline appreciably in this country, our future Congresses must be imbued with some far more rational sentiments than heretofore, so that they will loosen the Federal purse strings and apportion more money for experimental and investigational activities of this description.

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The object of this journal is to record accurately and lucidly the latest scientific, mechanical and industrial news of the day. As a weekly journal, it is in a position to announce interesting developments before they are published elsewhere.

The Editor is glad to have submitted to him timely articles suitable for these columns, especially when such articles are accompanied by photographs.

The Progress of the Einstein Judges

THE Einstein contest has now reached the stage where the participants are writing and telephoning to ask us when we are ever going to announce the winner. This, we suppose, was to be expected; certainly a bit of impatience may be pardoned in one who awaits an announcement involving himself and five thousand dollars. But we shall have to ask the contestants to display the same charity toward us that we are prepared to display toward them.

By a curious trick of fate, there were submitted in competition for the prize exactly 300 essays. Of course a few of these did not require serious consideration—this is inevitable in a contest of such magnitude. But after excluding all the essays that were admittedly not about the Einstein theories at all, and all those whose English was so execrable as to make them quite out of the question, and all those which took the subject so lightly as not to write reasonably close to the limit of 3,000 words, and all those which were given over to explanation of the manner in which Einstein's theories verify those of the writer, and all those in which the writer attempts to substitute his own cosmic scheme for Einstein's—after all this, there remained some 275 essays which were serious efforts to explain in simple terms the nature and content and consequences of Special and General Relativity.

Now there may be those who consider that two learned exponents of Einstein's doctrines ought to be able to rush through these 275 esays, allowing some ten minutes to each, and stating definitely at the conclusion of the process that No. 144 is unqualifiedly the best. Unfortunately, in practice it is not possible to do anything of the sort. It is necessary to read all the essays carefully, and not merely once but several times, gradually eliminating those which are not the best. As the number of survivors decreases it is necessary to bring to each essay a closer and ever closer scrutiny. Extreme care has to be taken in deciding whether the various essays preserve the proper balance between scientific accuracy and intelligibility of treatment. The final decision must perforce be a very delicate one: of several surviving essays that discuss the subject adequately and involve no material scientific infelicity, which embodies the best selection of material presented in the way best calculated to be understood by the intelligent general reader?

It is not the least of the difficulties involved that all this work has to be undertaken by the Einstein editor and the judges without disturbing any more than necessary the editorial routine, and without prejudicing at all the ordinary academic duties. It is therefore utterly out of the question to hang up any speed records in determining the winning essay. Early in the month, when we last communicated with the judges, the 275 had been reduced to 17, with a strong probability that of these, some half dozen would immediately fall by the wayside. But the long, hard pull will come in the effort to decide which of the last six or eight or ten is really the best combination of skilful planning and successful execution. We believe that the judges, with or without the final arbitration of the Einstein editor, will reach a decision in time for the winning essay to appear in one of our January issues. But it is entirely conceivable that the processes of final elimination may strike a snag that will make this out of the question. In any event, the contestants may be assured that their suspense will be ended, and the public at large that the prize essay will be presented in our pages, at the very earliest date possible.

Later we shall have something to say in detail about the character of the essays received, the scope of the contest, and other points of interest. For the present we may remark, as we have done explicitly on a previous occasion and implicitly just above, that the caliber of the essays submitted was on the whole high. There were many which would have been well worthy of the prize in the absence of others that were distinctly better—many which it was not possible to eliminate on the ground of specific faults, and which could only be adjudged "not the best" by detailed comparison with specific other essays. While nearly one-half of the essays followed substantially the same general outline, the other half showed almost as many ways of attacking the subject as if comprised of separate essays; so the aim of securing a wide diversity of treatment was fully realized. There is no slightest doubt that the contest has been a success; after the award of the prize our only embarrassment will be one of riches.

Are We to Become the War Pace-Maker?

A FEW years ago, in the course of a political speech-making tour, the President made a complete right-about face from his previous attitude of deprecating any military preparation, by stating that the United States ought to have "incomparably the strongest navy in the world." The phrase was at once caught up by the Hearst papers and became the watch-word of certain politicians among us, who apparently would like to see the United States take the place of Germany as the armament pace-maker of the world.

The SCIENTIFIC AMERICAN always has, and always will, set its face firmly against such a movement; for we consider it to be not only opposed to the spirit and purpose of the United States, but absolutely unwarranted by the present naval and political condition throughout the world.

Before the World War, all Americans, the General Board of the Navy included, who believed in a vigorous naval policy considered that the naval defense of the country would be complete if the United States possessed the second strongest navy in the world. Thanks to our great building activity during the war, and to the fact that Germany, formerly the second power in strength, has been eliminated, the United States is not only the second naval power at the present time, but is so firmly established in that position that in dreadnaught and battleship strength, it is fully equal to the navies of Japan, France and Italy combined. Not only has the goal been reached, but we are established in the coveted position with a preponderance of strength never dreamed of at the time when the President and his naval secretary were strenuously opposed to making the increase in our armaments which would give us second place in naval rank.

The war has left behind it a legacy of heavy taxation and the people of this country are looking to Congress to set in force a too-long-delayed policy of drastic economy. Of the total Government budget, some seven-tenths or more is devoted to wars past and future and the small remnant to civil purposes. There is a very proper demand that the pruning knife shall be put in where it will produce the quickest results. It was the universal hope that expenditures, particularly in the Navy, would be brought down to a reasonable limit. Hence, the announcement that the Secretary is asking Congress for between 600 and 700 million dollars appropriation for the Navy this year has been received with something like consternation. The naval budget before the war ran somewhere in the neighborhood of 150 million dollars. Allowing for the higher cost of materials and for a larger personnel, et cetera, a budget of four hundred million dollars should have been sufficient. The call for nearly 700 million dollars would seem to indicate that the Navy Department has taken no note of the altered world conditions, or of the plea for a general easing of the burden of taxation.

It would be easily possible to reduce the appropriation without any prejudice to our naval interests. Thus, we have under construction eighteen capital ships at a time when all other nations except Japan have ceased such construction; moreover the work being done by Japan is limited as to amount. Construction of the six 43,000-ton battleships, costing $40,000,000 each, could very well be allowed to rest until the financial condition of the country and the exigencies of the naval situation render work upon them possible and advisable. This subject, however, we shall return to in more detail in a future issue.

We note in a dispatch to the press from Washington that there was brought to the attention of Secretary Daniels the suggestion of Senator Borah for an agreement between the United States, Great Britain and Japan to curtail naval construction for a period of five years. Commenting upon this, the Secretary is reported to have made the extraordinary statement that an alliance of this kind would be interpreted as an attempt by these three nations to dominate the world. We remember the day when the Secretary assured us that if the United States increased its armaments, it would have the same effect. In his mind at least, our beloved country is a disturbing influence in the world, whether we build ships and guns, or whether we agree not to build them. Mr. Daniels tells us that the world is still "shell-shocked." If so, he has certainly got his share of the trouble; for if we credit him with being sufficiently humanitarian to wish to get the world out of its shell-shocked condition, we find that apparently his method would be to put our Navy in the position to get the world more shell-shocked, by doubling our present strength in ships of war.

Furthermore the General Board of the Navy recommends that in these piping times of peace, when practically the whole of the world has quit warship building, we not only complete the eighteen capital ships and other ships that we are building, but that Congress authorize four more capital ships, 30 10,000-ton cruisers, 8 gunboats, 18 destroyer leaders, 12 long-radius mine-laying submarines, 6 cruising submarines, 4 airplane carriers, 3 destroyers and 3 submarine tenders, or some 90 ships in all.

And so the merry game goes on; while the Secretary of the Treasury plays his accompaniment, by suggesting that the income tax for the majority of us good people be raised from four to six per cent.

The Promise of the Commercial Airship

WHEN "R-34" was in this country, in the summer of 1919, the officers in charge of the ship were unanimous in the belief that the commercial future of the airship was assured. This conviction was based upon the performance of "R-34" in crossing the Atlantic, and the certainty of an increase in the size of the airship, with all the well-known advantages which come with size, and secondly, upon certain experimental work which was then commencing, designed greatly to increase the carrying capacity and range of the airship by a more economical use of fuel.

Since that day, the Research Department of the Air Ministry has taken the matter in hand, and we understand that the preliminary investigations are full of promise. Stated in a general way, the economies which are aimed at are to be secured in two directions. The hydrogen which ordinarily is discharged is recovered and used in an engine designed for this purpose, and it is estimated that the value of the gasoline which will thus be saved will be sufficient to recover the cost of the hydrogen which is thus turned to useful account.

The reduction in the gross weight of an airship due to the consumption of gasoline, necessitates the discharge of hydrogen to compensate for the reduced weight. This hydrogen represents a dead loss. Experimental work is now being done in developing apparatus for condensing the water of combustion which passes out through the engine exhaust. It was this development to which the officers of "R-34" made particular reference in 1919, and the Research Department of the Air Ministry has found that it is possible to recover in this way a weight of water almost equal to the weight of fuel consumed; thus again reducing the amount of hydrogen which has to be discharged. Not only will there be a saving of hydrogen by these two methods, but in any given airship, it will be possible to carry a greater weight of passengers, mail, freight, et cetera.

Aeronautics

Sweden's Subsidy Plan.—From a message from Stockholm it appears that the Swedish Government is determined to encourage the development of an aerial postal service. It has decided to subsidize the Swedish Air Traffic Company by the payment of 500 kroner for each journey between Malmoe, Copenhagen, and Warnemunde. This scheme of subsidizing aerial travel companies has already been put into effect in other countries, with satisfactory results.

The Helicopter Problem.—Slowly but surely it appears that the helicopter problem is being solved. For one thing it is no longer being handled in a haphazard, hit-or-miss, guess-work manner. It is now receiving the attention of engineers and scientists who do not go into anything without acquainting themselves first of all with the mathematics and mechanics and the whys and wherefores. From *Aeronautics* we learn that M. Damblanc of France has recently carried out some experiments with a full-sized direct-lift machine under the auspices of the French Government. He is believed to be the leading authority on this subject at the moment. The development of a practical machine of this nature is of great importance, particularly to commercial aviators.

America's Speed Record.—The winner of the Pulitzer Trophy race held last Thanksgiving Day at Mitchel Field, Long Island, was Lieut. C. C. Mosley of the United States Army Air Service, who piloted the Verville-Packard American-built airplane to victory. The engine of this machine is the Packard 600-horse-power engine, designed by Col. Jesse G. Vincent. The Verville-Packard machine attained a speed of 178 miles per hour, thus marking a new record for American planes and engines. The Verville-Packard airplane is at present being overhauled at McCook Field and certain changes are being made in the gasoline feed, in the belief that when these are completed it will be possible to reach a speed well beyond 200 miles an hour and thus break all records.

A Small-Airplane Contest.—In view of the political situation in Italy preventing the entrants from having their machines ready in time, it has been decided to postpone the international competition for the Mapelli Cup. At this writing the contest has perhaps taken place, although we await such news with interest, together with the details. This cup has been offered by Mr. Luigi Mapelli for an annual competition for aircraft "having a wing-spread of not more than 6 meters over all, and driven by engines of total stroke-volume up to 4,585 cu. mil. inclusive." The competition is a speed one, and each succeeding race is to be for twice the distance of the preceding one. For this year the course selected is over a distance of 182 kilometers. At each of the designated points on the course the competitors will have to come down for three minutes, and the machine which completes the course in the shortest time will win the cup.

A German Gliding and Soaring Competition was recently held in the Rhön district by the League of German Model Aircraft and Gliding Clubs. The meeting was marred by one unfortunate accident, resulting in the death of the well-known pilot, von Loessl. This was due to breaking in the air of the elevator of his glider. A number of monoplanes and biplanes were entered, some of very novel design. Many of the entries had comfortable seats and landing gear, as distinguished from the old-time gliders in which the operator's legs swung below the planes, ready to take up the strain of a hard landing, often at the price of serious injuries. The longest distance covered by the gliders was 1,830 meters, with a duration of 142.5 seconds. That record was made by Klemperer, with a height of 330 meters. The apparent gliding angle of Klemperer's flight was one in thirty-one.

Airplane and Seaplane Design Prizes.—The British Air Ministry offered prizes totaling £64,000 for the best designs of airplanes and seaplanes; half of this sum was for large airplanes, £16,000 for small airplanes, and £16,000 for seaplanes. In the airplane competition only £24,000, or one half of the total, has been awarded, because the results "show less radical advance in general design than had been anticipated." In the seaplane class it is stated that a great advance in design and efficiency has been shown, and because of the excellence of the machines the second prize has been increased to £8,000 from the original £4,000, which was offered. Each machine had to have accommodations for four passengers, and the tests included rising from and alighting on both water and land, as well as making a figure-of-eight course on the water around two buoys placed within a rectangle measuring 200 by 100 yards. It is understood that a full technical report on all classes of the machine will be issued.

Science

A Reservation for the Australian Aborigines.—The commonwealth of Australia has taken steps for the preservation of the aborigines of that country, and has assigned a tract of public lands in the Northern Territories as reservation for the tribes. It includes the Mann and Petersen Ranges and practically the whole of Lake Amadeus. The governments of South and Western Australia have set aside adjoining areas for the purpose of this reservation.

Public Health Engineering Abstracts.—A new feature of the *Public Health Reports*, issued wekely by the U. S. Public Health Service, is the occasional publication of a batch of abstracts of current literature relating to sanitary engineering. The following list of titles from a recent instalment of abstracts gives an idea of the scope of the undertaking. All abstracts are short. "Protection of Surface Water Supplies Against Contamination," "Activities of the Division of Engineering of the Illinois Department of Public Health," "Nitrate Content of Certain Waters Considered Bacteriologically Safe," "Design of Aspirators for Sterilizing Waters," "The Water Supply of the American Expeditionary Forces," "Report of Sewage Experimental Investigations at West New Brighton, N. Y."

The Crop Protection Institute.—Under this name, and with the advice and assistance of the National Research Council, has been organized an association for studying insect pests and plant diseases and improving methods of fighting these scourges of agriculture. The temporary secretary of the Institute is Mr. Harrison E. Howe, chairman of the Division of Research Extension of the National Research Council, while the board of trustees includes nine scientific men representing leading organizations interested in crop protection and four representatives of industrial concerns manufacturing chemicals and appliances used in combating crop pests and diseases. There is always room for research in plant pathology. It is estimated that, in a recent year, the black-stem rust alone was responsible for the loss of 180,000,000 bushels of wheat in this country.

A New Cryogenic Laboratory.—One of the most interesting pieces of scientific news that has recently come from Washington is the announcement by Dr. R. B. Moore, of the Bureau of Mines, that his Bureau is installing a first-rate laboratory for low-temperature research. The immediate purpose of establishing the laboratory is to obtain data needed by the Government helium plants, but, says Dr. Moore, "there is a strong desire that this laboratory shall be of material use to science in general, and that it may be possible later on to make arrangements for its facilities to be used in special cases by men outside the Government service who are specially equipped for such work." The equipment includes two four-stage Norwalk compressors with a capacity of 75 cubic feet of free air per minute, which will be used for making liquid air and other purposes. There is also a vertical submarine type Norwalk compressor with a capacity of 12 cubic feet of air per minute to be used in connection with a liquid hydrogen cycle, and a similar compressor of smaller capacity for use in connection with a liquid helium cycle. The staff will include four technical men and two mechanics, under the direction of Dr. Moore.

The Campaign Against Rats.—A special conference of state health officers with the U. S. Public Health Service was held in Texas last August to consider the bubonic plague situation, and the resolution was adopted that "a nation-wide effort should be made to determine as accurately as possible the presence or absence of rodent plague in all ports of entry and principal centers of railway freight transportation in the United States," and further that the present situation in the southern states "should be the occasion for inaugurating a nation-wide campaign against rodents on economic as well as public health grounds." In this connection the Public Health Service has published full instructions concerning rat surveys and rat proofing and has drawn up a model building ordinance with a view to eliminating rats. It is a fact not generally recognized that, apart from their well-known powers of spreading disease, rats impose a very serious economic burden upon the community. In this country it is estimated that their depredations amount to $167,000,000 a year. The rat population of the United States is conservatively estimated to be equal to the human population, and similar figures have been published for Great Britain, Denmark, France and Germany. The annual upkeep per rodent is estimated at $1.80 in Great Britain, $1.20 in Denmark, and $1.00 in France. (These are pre-war figures.)

Industrial Efficiency

Pulverized Lignite or brown coal is being used as fuel in Australia. The lignite is mined in either shafts or open cuts, the coal crushed on the spot to egg size, then hoisted to the air-drying tipples at the surface by bucket conveyors. After drying about seven days, the coal is relieved of practically half of its moisture content and is ready for final treatment. This final process, which should be undertaken near the place where the fuel is to be used, consists of again crushing the coal—to about ½-inch mesh—after which it is passed through a rotary drier, where the moisture content is reduced to about 10 per cent. The fuel is then pulverized, separated by air, and stored in bunkers.

Germany's Modified Barter System.—One development of the impasse in import and export business between Germany and other countries growing out of the depressed value of the German mark has come as a modification of the barter system. Arrangements have been made by various British interests whereby there is practically an agreement on the part of German manufacturers to manufacture goods for account of the British or other interests out of raw materials furnished by the latter and for a percentage of the goods as a commission or profit. Most of the work in this line has been done by British cotton interests who have arranged to furnish German cotton mills with raw cotton and take from them cotton yarn manufactured therefrom, the German manufacturers retaining a portion of the yarn as their payment for the use of their plant, of their labor and fuel outlays, and other costs of manufacture.

An Inserted-Tooth Metal Saw which promises to meet a long felt demand has been invented, and is being placed on the market. This saw was especially designed to meet the requirements for a saw to cut structural iron, I-beams, channels and stock with thin walls that could not be cut so successfully with other saws of similar design, because the pitch or spacing of the teeth was not fine enough to keep two teeth in the cut at all times in this work. This new saw through its arrangement and closer spacing of teeth provides for smoother running and eliminates chatter which is often noted where the teeth are placed farther apart in the plate. It is a fast cutting saw and is fitted with as many teeth as it is possible to fasten securely into the plate while retaining the perfect alinement of teeth and strength of plate necessary to stand up and cut true. These saws are being made from 10 inches in diameter with kerf of ¼ inch and maximum of 40 teeth, to 50 inches in diameter, 15/32 inch or 7/16 inch kerf with 210 teeth as the maximum number.

Europe's Interest in American Advertising is steadily growing. Certain American periodicals have lately been asked by European manufacturers about rates, circulation, and other data of interest to prospective advertisers. Most of these inquiries are from Holland and Germany, although not a few are from France and Great Britain, with a lesser number from Italy. European manufacturers are beginning to face a serious over-production so far as their home market is concerned, and it is altogether to be expected that they are casting covetous eyes toward the Amerian market. They evidently intend advertising their wares in the very near future. Because of the rate of exchange, they can undersell American products in many different fields while still making a handsome profit for themselves—at least under the existing tariff. We have already seen the new European efforts in cameras and lenses, certain chemicals and drugs, print paper, toys, books, fine instruments, photographic supplies, and so on. Are these but the vanguard of a formidable European invasion?

Industrial Machinery in France and Belgium.—"Europeans have overestimated their capacity for rehabilitating their industries. . . . American cooperation applied to the reconstitution of essential producing industries would provide a considerable market for American industrial machinery and at the same time would insure raw materials and more work for European machinery factories. . . . More needs to be done to gain the confidence of European industrialists." The foregoing are the expressed opinions of Trade Commissioner Charles P. Wood in a report on industrial machinery in France and Belgium just published by the Bureau of Foreign and Domestic Commerce of the Department of Commerce. The publication is known as Special Agents Series No. 204, "Industrial Machinery in France and Belgium." Copies can be purchased for 10 cents from the Superintendent of Documents, Government Printing Office, Washington, D. C., and from the district and coöperative offices of the Bureau of Foreign and Domestic Commerce located in different cities.

XUM

Our Lagging Gold Production

Reasons Why Less of the Precious Metal Is Being Produced Now Than for Many Years Past

By Arthur L. Dahl

WILL the world run short of gold? This is a question that is bothering our economists, and the answer is not as reassuring as it might be. Individuals have grown accustomed to the absence of the golden eagle from their pockets, but they had the vague comfort of believing that there was a big pot of gold somewhere in the world, and that being a basic metal it would be impossible to lose any permanently. But an analysis of the world's statistics shows that gold production is not keeping pace with the demands, and that unless its use for the arts and sciences is restricted, there will not be enough to support the tremendous expansion of credit which is based upon the gold standard.

In the last 425 years of which we have records of gold production, the total amount of the precious metal taken from the earth and added to the world's supply was only a little more than seventeen billion dollars. Of this production over half was mined in the last 25 years, during which period the average annual production of new gold is approximately $375,000,000. Of this the United States produces less than $100,000,000, and this production is gradually diminishing from various causes.

The quantity of gold used in the arts has increased by leaps and bounds until now it amounts to about $40,000,000 annually in the United States alone. It is estimated that there is about $9,000,000,000 in gold in the national and bank reserves of the world, and of this amount the United States holds over one-third, or an increase of more than two billion dollars since 1900.

In spite of the fact that gold is distributed in every continent and is mined in about 60 different countries, its production has never been considerable in any one locality, with a few possible exceptions. The gold fields of the Transvaal, South Africa, are the heaviest producers, and now yield about 40 per cent of the world's gold, as against about 20 per cent from the United States. The Transvaal mines employ 200,000 natives and 20,000 white men, or more than are employed in all the metalliferous mines in the United States. In the United States, gold production, although constantly diminishing, has been kept up to present figures largely through the operation of gold dredges, which extract the grains of gold from lands incapable of being profitably mined by other methods.

The gold output of the world seems to have passed its zenith and to be on the decline. Existing ore bodies are being worked out and few new ore bodies of importance have been added to the gold and silver producers in recent years. Much of the gold now produced is taken from low-grade ores that are profitably worked only because of the improved technique in mining and metallurgy developed by engineers. The yields and costs vary in different districts and in different mines in each district. The greatest gold producers have been mines of low or moderate yield per ton, but with great mass occurrence and good conditions for economical working. For example, the Homestake mine in South Dakota, which has been working since 1875 and has produced over $147,000,000, has operated entirely in low-grade ore averaging not over $4 per ton, and yet this mine has made a profit of over $40,000,000, or 27 per cent of its output. Another famous mine, that of the Alaska Treadwell group in Alaska, has crushed and treated 26,000,000 tons of ore, yielding $63,000,000, or $2.37 per ton, and at a cost of $1.42 per ton. Another Alaska mine is reported to have worked over 2,000,000 tons of ore giving a yield of less than $1 per ton, and yet made a profit, but this is only possible by a combination of unusually favorable natural conditions and a most efficient organization backed by ample capital.

Since the beginning of gold mining in the Witwatersrand district, South Africa, in 1887, there has been produced there a total of $2,571,992,355 with a gross profit of over $600,000,000, but while production is holding up pretty well in this district there is no present likelihood of developing new and unknown deposits, and a steady decline is looked for in the African fields.

Australia reached the maximum of its production in 1903, when $87,000,000 in gold was mined, but since then it has gradually declined, until in 1916 the returns were only about $39,000,000. Canada, too, has declined from a production of $28,000,000 in 1900 to less than $15,000,000 in 1917. Russia and Siberia in 1914 mined about $28,000,000 of gold, but in 1918 this figure had dropped to $12,000,000. The same story is told of all other gold-producing countries, including the United States, for in 1919 the world produced but $350,000,000 in gold—$31,000,000 or 8.1 per cent less than for the preceding year. With this loss for 1919, the total amount of the decline in the world's gold production for the past four years was $119,000,000 or over 25 per cent.

The United States has been, probably, the largest gold-producing country on earth, for up to 1917 it had mined a total of $3,912,,708,000. In 1915 it produced over $101,000,000, but in the following years it has gradually declined in production until in 1918 the gold amounted to only $68,646,700. There are six States and the territory of Alaska that have for the last six years produced approximately 90 per cent of the gold of this country. They are, in the order of their production, California, Colorado, Alaska, Nevada, South Dakota, Arizona and Montana. For the last two years all of these States have shown marked declines in the amount of gold produced, and the lode or quartz mines have shown the greatest falling off, largely due to the increased cost of mining, compared with the fixed value of the gold recovered. California and Alaska have maintained their output largely through the operation of gold dredges, which, though feeling the effects of the increased cost of production, had to keep operating on account of the maintenance of their organizations and the indirect loss that would be sustained by

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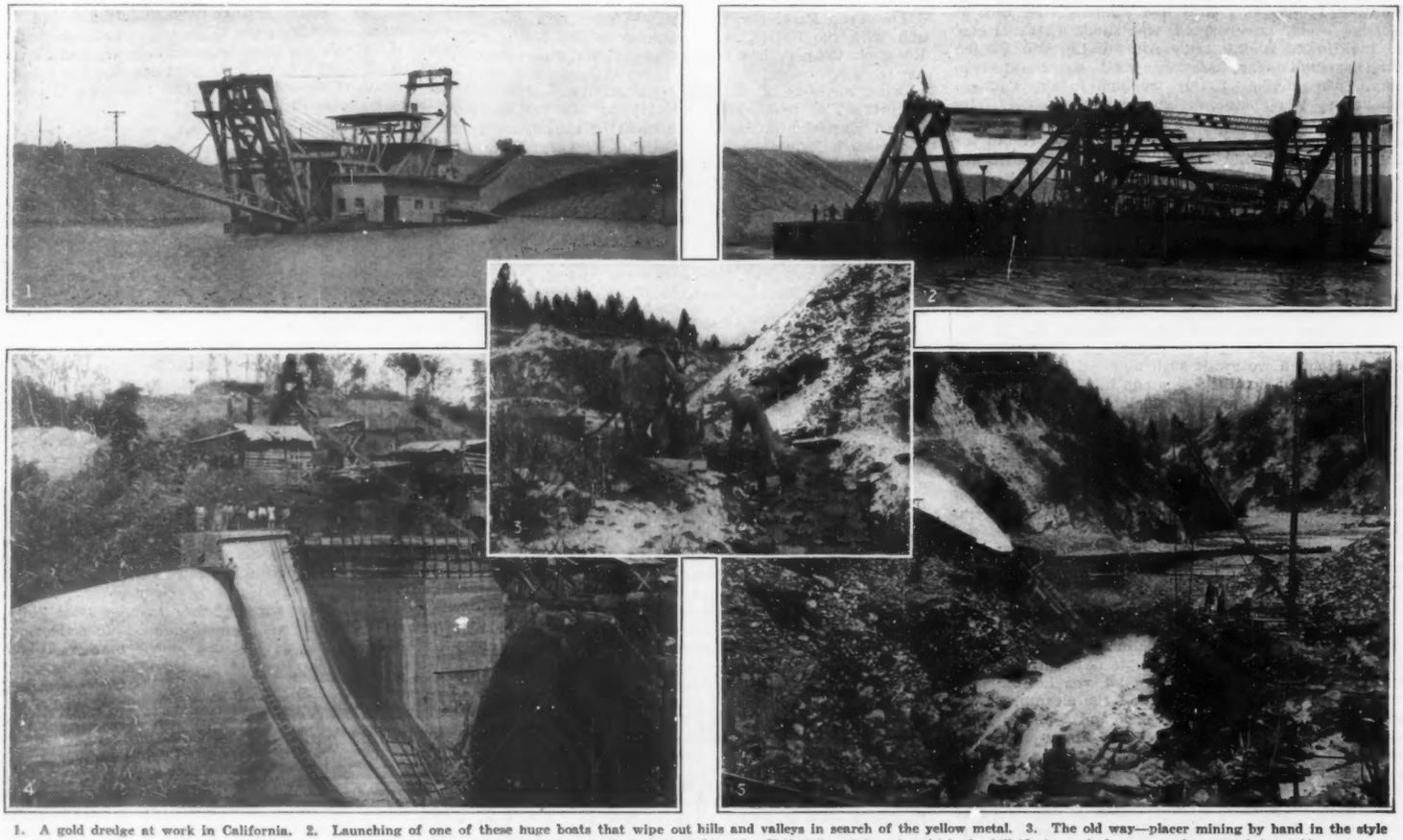
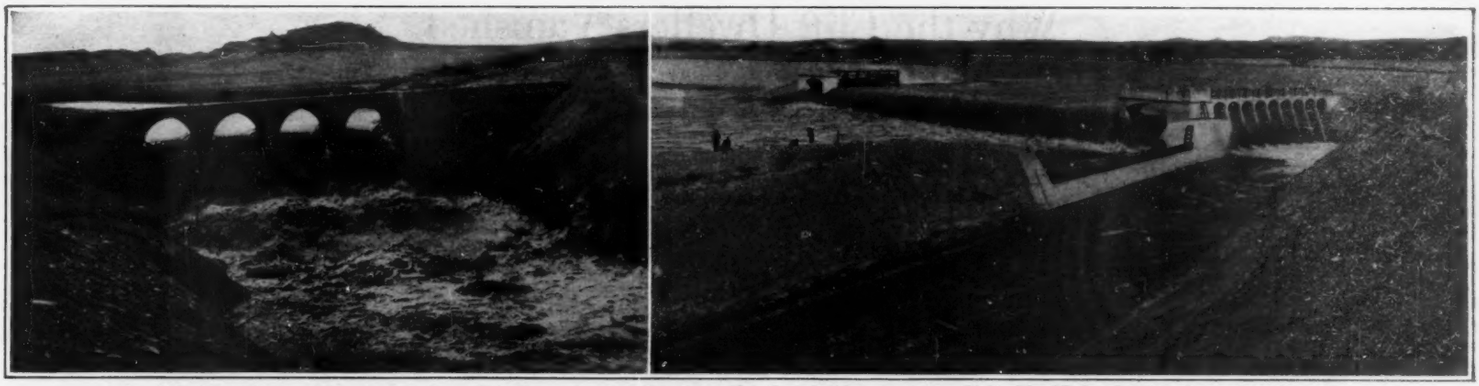


1. A gold dredge at work in California. 2. Launching of one of these huge boats that wipe out hills and valleys in search of the yellow metal. 3. The old way—placer mining by hand in the style of the 49's. 4. Dam constructed in connection with gold-dredging operations in British Columbia. 5. Hydraulic mining, in which the hillside is washed away, to be treated for gold on a magnified placer basis

Some of the modern methods by which gold mining is placed on a quantity basis in connection with large deposits of low grade



Left: Where the canal takes a slight drop. Note the great masses of water passing through this narrow cut. *Right:* The Whalen diversion dam and headworks

Some of the construction involved in the North Platte irrigation, and already completed

The North Platte Project Today

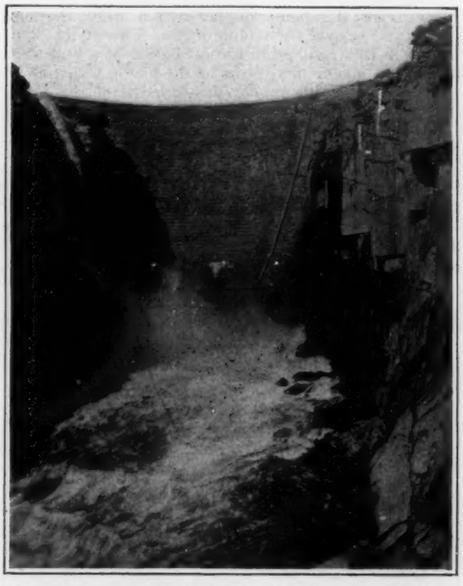
By J. F. Springer

A PORTION of the Fort Laramie Unit of the North Platte irrigation enterprise was thrown open on March 5, 1920, to men who had been in the Government's military service in the Great War. There were only 79 farms offered for entry, and yet 9,000 men sought information as to the offer and about 1,500 ex-soldiers actually assembled at Torrington, Wyoming, to compete for the land. Some 10,000 acres were actually allotted. These facts illustrate two things: (1) That the experience of earlier settlers on reclaimed territory at other points has been good, and (2) that ex-soldiers are rather eager for farm homes.

The North Platte project, viewed as a whole, is one of the greatest anywhere. It is already guaranteeing 14,000 farms against drouth by means of its 12,000 main canals and ditches. The crops thus provided for are worth annually some $80,000,000. The value of these irrigated lands runs up to $200,000,000. These statements represent what has been accomplished. The recent competition at Torrington illustrates the fact that the enterprise is still being developed. This great project contemplates, in fact, the absolute control of a great river and the utilization of its waters to just about the limit of the possibilities.

The controlling feature in the project is Pathfinder Dam. This structure cost upward of $1,200,000 and has been and is one of the notable dams of the world. It is 218 feet high, and has a length along the crest of 600 feet. It stands in a canyon where the great river passes between granite cliffs that are almost vertical, they are so steep. The dam was constructed largely of the granite found on the spot. Nevertheless, from the distant railway (C. B. & Q. R. R.), the construction machinery, the general supplies, the necessary cement, and so on, had to be painfully transported across the intervening desert. The power plant was located high up on the cliffs above the site of the dam. Cableways strung across the canyon assisted in handling the work. Excavating to a depth of 12 feet, the workmen came upon bedrock. Big cranes or derricks were stationed down at the bottom of the canyon and along the sides. And a great tunnel was cut for the purpose of passing the waters of the stream during construction. However, real floods had to be dealt with, and these simply swept over the work, leaving it intact.

Dynamite, pluck and engineering knowledge and equipment proved themselves competent to attack and solve this problem, and to do it economically as well. The lake created by damming the North Platte at this point has a storage capacity of 1,025,000 acre-feet—enough water to flood the whole State of Rhode Island to the depth of a foot. It is said, in effect, that the capacity is only a trifle less than the combined storage capacities of the Wachusett, New Croton and Ashokan reservoirs. The masonry of the dam amounts to 60,400 cubic yards. Despite the fact that the site of this dam is located 45 miles from the nearest railroad, the cost of construction was very moderate. The entire river is controlled. This was a big conception. The Platte is a very long stream rising in the mountains of Colorado and flowing through a large part of Wyoming and dividing the whole State of Nebraska lengthwise. The head-waters lie between the Medicine Bow and the Sierra Madre ranges, near the Continental Divide in north Colorado. On the other side of this Divide, but farther north and west, are the head waters of one fork of the Snake River. The one sends its waters to the Gulf of Mexico and the Atlantic Ocean, while the other contributes to the Pacific Ocean. The North Platte and Snake figure in great irrigation enterprises.



Lower face of the Pathfinder dam, showing the discharge of 6,500 second-feet

Pathfinder Dam is located far up in the valley of the North Platte at a point some three miles below the location where the Sweetwater River joins the main stream. This is in central Wyoming in a very elevated region. This may be understood from the fact that

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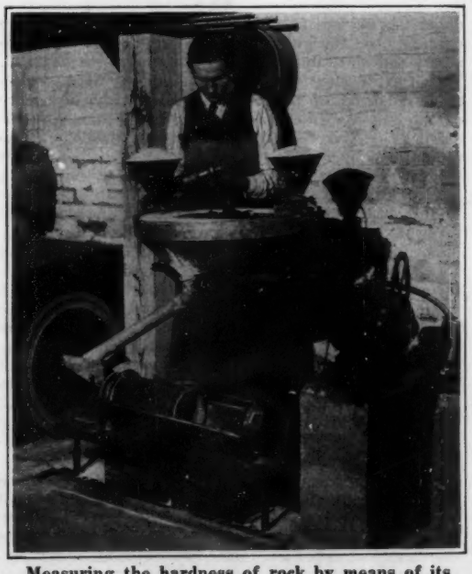


Measuring the hardness of rock by means of its resistance to grinding

How Hard Is a Rock?

By S. R. Winters

THIS is a question which appears to be quite as empty and meaningless as another inquiry, "How sour is vinegar?" Rocks, however, vary in quality as well as other substances of less pronounced characteristics and in road building it is essential that only the choicest specimens be selected. To the farmer who is ridding his estate of stony obstructions, rocks have no pereferential rating, the entire unassorted formation being objectionable. Builders of highways classify them with respect to their relative hardness, toughness and binding power.

Clearly, physical properties of rocks are not to be determined at a cursory glance, the material entering into the construction of macadam roads undergoing exacting laboratory requirements as a guarantee of its resistance to the wearing action of traffic, especially iron-tired vehicles. A machine in use in the laboratory of the United States Bureau of Public Roads literally separates the brittle rocks from the hard ones, setting its seal of approval upon the latter. Hardness, as it applies to rocks used in constructing roads, is that quality which successfully resists the tendency of vehicles to convert into dust fragments of rock forming the wearing course of a macadam road. Toughness implies ability to resist fracture under the pounding pressure of traffic, while binding power indicates the capacity which dust of a rock possesses or develops by contact with water for welding or cementing the larger rock fragments together. Such a quality is the tie that binds when the shearing action of traffic is spending its force, a condition especially desirable in water-bound macadam construction, where it is relied upon to maintain the integrity of the wearing course as the road surface is shaved away by vehicular traffic.

The machine, shown in the accompanying photograph, reflects the relative hardness of rocks. It consists of a circular steel disk, which is revolved in a horizontal plane by bevel gear driven by a pulley. A brass grip clutches the test specimen, the clasp being held in a vertical position over the steel disk by inserting it in the sleeve. The latter is of such dimensions as to constitute a sliding fit, permitting free vertical movement but forestalls a sidewise tendency of the grip. Crushed quartz, the laboratory wearing material, is fed on to the disk through a funnel, the lower end of which forms an opening one-fourth of an inch in diameter. The sleeve is so situated that the center of the grip, when in position, will be 26 centimeters from the center of the rotation of the disk. A galvanized-iron hopper, located under the disk, receives and conveys away the used sand.

Crushed quartz, as the abrasive agent, is screened for passage through a standard sieve with 30 meshes to the linear inch and is retained on a standard sieve having 40 meshes per linear inch. Commercial sand of this specification is not easily available, so it is a practice to specify a sand not more than 5 per cent of which will be retained on a No. 30 sieve and not more than 25 per cent of which will pass a No. 40 sieve. A core 25 millimeters in diameter and 10 centimeters long is cut with a diamond drill from the specimen subjected to the hardness test. Once thoroughly dried, the piece of rock is placed in the brass grip of the testing machine, leaving one inch projecting from the lower end. The grip is inserted in the sleeve, the lower end of the specimen resting on the steel disk. The funnel is filled with sand and the machine operated until the lower end of the rock has worn away, down to the plane of the disk.

(*Continued on page 640*)

XUM

Why the Cliff Dwellers Vanished

A Modern Industrial Hazard that May Have Existed in Prehistoric Times

By Frederick L. Hoffman

THERE can hardly be a more interesting speculation than the racial origin and the rise and fall of what must once have been a considerable population of a region now marked only by the ruins, the shrines and the temples brought to light by patient excavation throughout vast areas of the great Southwest. It hardly admits of a dispute that the original cliff-dwellers, as they are most familiarly known, had passed away long before the Spaniards visited that region and, beginning with about 1759, inscribed their names on Inscription Rock, now fortunately a national monument. That the aboriginal life was extensive in area and that the population was considerable in numbers is made evident by the many ruins, nowhere so clearly indicated as in Mesa Verde Park in southeastern Colorado, just north of the New Mexico line. On the topographic survey map of Mesa Verde Park five hundred and seven ruins are indicated, differentiating cliff-dwellings and remnants of the Pueblo type. Two hundred and two of these ruins are located within a distance of five miles from Cliff Palace, and within a radius of ten miles from this central point may be found no less than ninety-five per cent of the entire colony of identified ruins. Of the five hundred and seven distinct ruins fifty-two and a half per cent are located on the left-hand side of the canyons, as opposed to forty-seven and a half per cent on the right-hand side. The entire area is two hundred and eighteen square miles in extent, including a portion of the Southern Ute Reservation and the great Montezuma Valley, which touches the southern border of Utah.

This area is not symmetrical in its relation to what was probably the center of religious life and industrial activity, readily identified by the ruins of Cliff Palace and Sun Temple, which lie just north of the State line. It is, therefore, difficult, if not impossible, to estimate even approximately the probable population of this area, since it is practically certain that further excavations will reveal numerous ruins in adjacent territory, as yet but superficially explored. It is most regrettable that practically all the accounts of archaeological explorations in the Southwest should be wanting in maps useful for the purpose of tracing known ruins with certainty, both as to location and type. There would seem to be no excuse why such an elaborate work as the report on the "Explorations in Northeastern Arizona" by Kiddle and Guernsey should be entirely wanting in a map, without which all estimates of the probable population must be a matter of mere guesswork opinion. As an admirable illustration of the type of maps useful for the purpose, although on a scale hardly sufficient for exact identification, reference may be made to the really extraordinary dissertation on ancient communities in the American Desert, published by Prof. Edgar L. Hewett, in French; Geneva, 1908. (*Les Communautes Anciences dans les Desert Americain*).

Primitive Stone-Working Technique

The condition of these ruins, many of which have only been brought to light during very recent years, particularly under the direction of Prof. Jesse Walter Fewkes, of the Bureau of Ethnology, is indicative of a relatively high degree of attained civilization by a population thoroughly representative of the late Stone Age. An immense number of stone implements have been found, suggestive of the conclusion that the stone work of these ancient inhabitants was the predominating industry, universally carried on as a matter of paramount necessity by a considerable portion of the male population. The processes employed in shaping or manipulating stone materials by our early Indian tribes have been learnedly discussed by numerous writers, but for the present purpose it will be sufficient to quote from a contribution by Professor Holmes to the "Handbook of American Indians" the statement that there were used "(1) fracturing processes, variously known as breaking, spalling, chipping, flaking; (2) crumbling processes, as battering, pecking; (3) incising or cutting processes; (4) abrading processes, as sawing, drilling, scraping and grinding; (5) polishing processes."

We have in this description all the elements typical of an industry which in modern times has been materially modified only by the introduction of iron and steel tools on the one hand, and pneumatic cutting methods on the other. The labor in the primitive stone industry must not only have been much more arduous and exacting (for years must have been necessary to produce some article of special merit), but it is also safe to assume that the industry must have had a most important bearing upon the health, physical strength and disease liability of the cliff-dwellers.

That the ancient stone work was in many respects a craft, requiring a much higher degree of specialized individual skill than the modern mechanical processes, is made evident by a further observation by Professor Holmes, who remarks that, "In shaping blades a suitable piece of brittle stone, preferably a flattish pebble, bowler, flake or fragment was selected, and with a hammer-stone of proper weight, usually globular or discoidal in form and generally not hafted, chips were removed by means of vigorous blows about the periphery, alternating the faces. The utmost skill of the operator was exerted to cause the flakes to carry from the point of percussion near the edge across and beyond the middle of the sides of the stone, failure in this resulted in the formation of a high ridge or node on one or both faces of the blade, which effectually prevented the proper development of the form."

The Atmosphere of the Stone Workers

The foregoing statement emphasizes the conclusion that in ancient stone work the processes, the personal exposure to health-injurious conditions and the after-effects may possibly have been even more serious than is the case at the present time. The effects of stone work vary, of course, according to the chemical and microscopical nature of the dust inhaled in considerable quantities during the working processes. While granite dust is probably the most injurious, limestone, bluestone, and slate dust are unquestionably less harmful. Thus far no scientific observations appear to have been made a matter of record, clearly disclosing the nature of the different rocks out of which the ancient cliff-dwellers carved their dwellings or by laborious manipulations made the tools indispensable to the needs of primitive life. In many sections the remaining work indicates the extraordinary amount of skill and painstaking care in the cutting and surfacing of stones used for walls or in the building of community dwellings, underground kiwas, etc. The best illustrations of ancient dwellings or cliff-alcoves (originally some back rooms of talus pueblos) are contained in Report No. 5 of the Archaeological Institute of America on the "Excavation of Tyuonyi, New Mexico" by Prof. Edgar L. Hewett. This paper was followed by an equally interesting report, including numerous illustrations of rock dwellings with floor plans and tables of dimensions and in Paper No. 10 on the "Excavation of El Rito de los Frijoles." Both of these papers were issued at Santa Fe, N. M., in 1909 by the Archaeological Institute of America.

IN many parts of our Southwest it is clear that we have the remains of what once must have been a rather numerous and certainly a partially civilized race. But the cliff-dwellings are empty, and their builders vanished—so long vanished, in fact, that even among the pueblo dwellers who succeeded them little or nothing is known of them and their fate. It seems plain enough that these later people did not drive their predecessors out by force; had they done so, they would certainly have preserved this heroic event in their history through song and story. A rational answer to the question "What became of the cliff-dwellers?" is attempted in this article by Dr. Hoffman, and whether one agrees with his conclusions or not, it must be admitted that a really rational answer is what he gives.—THE EDITOR.

It is not generally known that the disease resulting from the continuous and considerable inhalation of stone dust is not primarily pulmonary tuberculosis, but fibroid lung disease, which may or may not, according to the chance of exposure, result in a subsequent tubercular infection. In other words, even if pulmonary tuberculosis did not occur among the ancient cliff-dwellers, there cannot be the slightest doubt but that fibroid lung disease must have prevailed to an extraordinary extent among the stone-workers during the period when the stone industry had reached its highest development or near the date when the ancient civilization had practically come to an end.

Dwellings Carved from Solid Rock

But there is another aspect to this question to which attention may properly be directed. Anyone who carefully examines into the rock dwellings, particularly as observed in Frijoles Canyon, must needs have been amazed at the enormous amount of labor involved in the literally carving out of the solid rock of the many large and small rooms, or cliff-dwellings, extant at the present time. These rooms are almost invariably dark and the dust exposure during the process of working, as well as later, during occupation, must have been considerable, if not enormous. After carefully examining into many such dwellings (for I have not had the dust either chemically or microscopically examined), there remains no doubt in my mind that the health-injurious consequences of the stone industry, both in its industrial and home-building aspects, must have been, in the long run, disastrous to health and life.

According to Professor Holmes: "Owing to differences in the composition of the rocky strata, the natural shelters occupied by the cliff-dwellers are greatly varied in character. While many are mere horizontal crevices or isolated niches, large enough only for men to crawl into and build small stone lodges, there are extensive chambers, with comparatively level floors, and with roofs opening outward in great sweeps of solid rock surface, more imposing than any structure built by human hands. These latter are capable of accommodating not merely single households, but communities of considerable size. The niches occur at all levels in cliffs rising to the height of nearly a thousand feet and are often approached with great difficulty from below, or, in rare cases, from above. Where the way is very steep, niche stairways were cut in the rock face, making approach possible."

I have given this extract also in its entirety, to convey as clearly as it is possible a picture of the ancient domestic life of these people, due to the practically unbelievable natural difficulties overcome in countless instances, which would seem to defy the power of human adaptation. But there must have been continuous exposure to stone dust in all essential operations, from road-building to home-building, and from the making of corn-grinders to spear-heads and battle-axes. As said by Professor Holmes: "The masonry is excellent and while the stones were rarely dressed, they were carefully selected, so that the wall surface was even and in some cases a decorative effect was given by alternating layers of smaller and larger pieces and by chinking crevasses with spalls.

"The walls were sometimes plastered inside and out with clay paint. The doorways were small and squarish, and often did not extend to the floor, except an opening or square notch in the center for the passage of the feet. The lintels were stone slabs, or consisted of a number of sticks or small timbers. Windows or outlook apertures were numerous and generally small."

A Passion for Death-Dealing Labor

All of this would seem to indicate an almost unbelievable amount of manual labor on the part of a remnant of what must once have been an extensive civilization. Another essential fact, which requires to be kept in mind, is as pointed out by Professor Holmes, that "The cliff-dwellings to which the term 'cavate' is applied, are not built, but *dug* in the cliffs." The ruins of today are of course but the survival of vast pre-existing building operations, and, as said by Dr. Prudden "Excavations which have been made in several places show that buildings themselves of great age have been made on the top of still older structures." These digging and building processes must have involved a very considerable, if not disastrous, exposure to health-injurious dust. Even at the present time the dwellings contain dust accumulations, which would seem to indicate that the process of dust inhalation must have been practically continuous and universal. While modern stone-cutting is more injurious, on account of the use of pneumatic tools, there are at least the advantages of qualified medical aid, of more nourishing food, of better conditions of home life and prolonged periods of rest, with

(*Continued on page 641*)

The New President of the American Association

By Marcus Benjamin Ph.D.

THE American Association for the Advancement of Science has had three wonderful permanent secretaries, each of whom has enrolled his name for all time among those of the great men on the roster of American Science. The able Lovering gave place to the genial Putnam, who in turn passed the mantle on to the brilliant Howard. Each of these three men was rewarded at the close of his term of office by an election to the highest place in the gift of the association.

Leland Ossian Howard is the son of Ossian Gregory and Lucy Dunham Howard, and was born in Rockford, Ill., on June 11, 1857. In early boyhood his parents settled in Ithaca, N. Y., where he was prepared for college and then naturally entered Cornell, in which university he pursued the modern course and graduated as B.S. in 1877. For a year he continued at Cornell, following post-graduate work preliminary to medical studies, including special courses in entomology—a subject to which he had been devoted as a child—under John H. Comstock, now the Nestor of American entomologists.

His ability in this branch of natural science was apparent from the beginning, and a vacancy in the entomological service in the U. S. Department of Agriculture becoming available led to his appointment as assistant entomologist to the Bureau of Entomology in 1878, with which service he has since continued, becoming chief in 1894. During these years he has also held the office of Honorary Curator of the Division of Insects in the U. S. National Museum, the duties of which are scarcely secondary to those of his office in the Department of Agriculture. Dr. Howard has also served as consulting entomologist to the U. S. Public Health Service since 1904 and at present he is also a member of the Executive Committee of the National Research Council.

During these many years rich with the fruits of patient research and the practical applications of their results, he himself notwithstanding the heavy duties of his administrative work, has made time to study parasitic insects and their utilization as enemies of crop pests. The introduction of the European and Japanese natural enemies of the gipsy moth and the brown-tailed moth was done at his suggestion and under his direction. Also, he deserves special credit for his work on medical entomology, such as the carriage of disease by insects. His writings on mosquitoes and the house fly have been of very great assistance to persons engaged in the fight against those disease-bearing insects, and the early measures against mosquitoes in Havana and Panama were based upon his published recommendations.

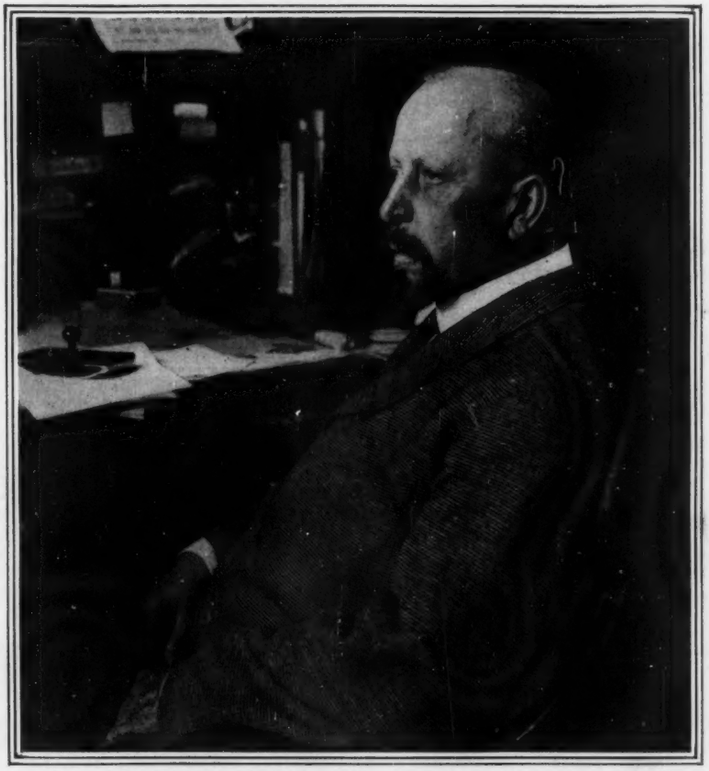
His remarkable industry and untiring energy is further manifested in a scientific bibliography that comprises over eight hundred separate titles, and he is the author in book form of "Mosquitoes—How They Live," etc. (1901); "The Insect Book," (1902); and "Mosquitoes of North America," (1912). Besides these he was for some years the editor of "Insect Life," a technical journal published by the Department of Agriculture, as well as preparing definitions in entomology for the Century and Standard dictionaries and writing articles on his specialty for the New International Encyclopedia and other works of reference.

His ability to present in popular language the technicalities of his specialty led to lectureships at Swarthmore College and at the post-graduate school of Georgetown University. He has lectured frequently before the Brooklyn Institute of Arts and Sciences and in 1901 gave a course before the Lowell Institute, in Boston, Mass. The first Sir Sanford Flemming Foundation lecture in Toronto was given by him, as well as the public lecture before the Royal Society of Canada in 1903.

His work has not failed to receive deserved recognition. The degree of M.S. came to him from Cornell in 1883, and that of Ph.D. from Georgetown in 1896, while in 1911 he received the honorary conferment of M.D. from George Washington and of LL.D. from Pittsburgh. Also, during 1900-5 he was an alumni trustee of Cornell.

Besides having held the presidency of the Association of Economic Entomologists (1894), the Biological Society of Washington (1897-8), the Cosmos Club (1909), the Washington Academy of Science (1916), the Entomological Society of America (1919), he is a member of the American Philosophical Society, the American Academy of Arts and Sciences and the National Academy of Sciences. In addition to corresponding membership in a number of European academies and learned societies, he is an honorary member of the Entomological Societies of London, France, and Stockholm, of the Royal League of Agriculture of Portugal, the Association of Economic Biologists of Great Britain, the National Society of Acclimatization of France, and one of the two American members of the Academy of Agriculture of France.

Dr. Howard became a member of the American Association at its Cleveland meeting in 1888 and a year later was advanced to the grade of Fellow. In 1893 he was chosen secretary of Section F in Zoölogy and served that section again in 1895 as its chairman and once more in a similar capacity in 1897. He was elected permanent secretary of the association at the Toronto meeting in 1898 and from that time until the close of the meeting in 1919 continued to fill that important office. His efforts in building up the association have succeeded in more than quintupling its membership and his many friends were glad to testify to their appreciation of his merits by the unanimous acceptance of his name for the presidency in 1919.



Dr. Leland Ossian Howard, the new president of the American Association for the Advancement of Science

Plant Movement and Radiant Energy

THAT a sunflower will turn on its stalk sunward from dawn throughout the entire day is known to everyone; and that branches of trees grow more luxuriantly southward than northward, is a matter of common observation. Similar evidences of the heliotactic response of growing plants to radiant energy will readily occur even to persons not especially interested in plant physiology. On the other hand, the writer has found, by questioning numerous friends and acquaintances, that few persons who are not botanists are aware of the very active response of cut (detached) branches of trees, especially trees of the genus *pinus*, to radiant energy, whether proceeding from a common electric-light bulb or from the sun. In this connection, the following experiment, demonstrating the "motor-power" of these two manifestations of energy acting on plant cells may be of popular interest, since the phenomenon may readily be produced by anyone at will.

Place three or more stems and twigs of any "evergreen" species of tree (pine, hemlock, cedar, etc.) in a vase or jug, with or without water, and suspend the vessel by means of twine or ribbon from a shelf or a projecting "arm," so that it may move without obstruction, near a window with sunward exposure. Let the center of gravity of the overhanging twigs be somewhat away from the direct sunlight. It will then be seen that the sunlight will pull the green twigs, together with their container, away from the center of gravity, but that the pull is not sufficient to hold the plant in this position, and it will return almost immediately to its original station; but only to be pulled sunward again within a moment or two. The effect, then, is an almost continuous movement to and from the sunlight, with short pauses between; neither gravity nor radiant energy being competent to hold the plant still.

When evening comes, an electric bulb of at least sixty-watt power, placed even a few degrees on either side of the center of gravity, will produce the same constant swing to and fro. Tobacco smoke in the air seems to increase the arc of the plant's movement. The sap drying at last, the movement ceases; addition of water brings renewal of motion.

Now try to conceive the actual internal mechanism of this constant fluctuation produced by sunlight or electric rays. Is it *heat* that draws the plant toward the light? If this were the explanation, a sad-iron heated to the electric bulb's temperature would secure the same motion. Try it. Is the rhythmic movement caused by the "light"—does electric or sunlight *pull* a green bough when separated from the living tree? Light is not regarded as a substance, as matter, because experiment proves that darkness can be produced by the addition of two portions of light. Such an experiment is not possible with substances, as usually understood. How, then, can it attract, pull, these several twigs?

That light can push or repel matter is well known. Such a repulsive force was attributed to sunlight by Clerk-Maxwell (1870), when he propounded his electromagnetic theory of radiant energy; and this mechanical pressure was experimentally demonstrated and measured in 1901 by Peter Lebedew, and soon thereafter his work was carried forward by Nichols and Hull. The repulsive pressure of light has been fairly well explained. But how can the light force green twigs to turn (carrying the vessel) in its direction as against the pull of gravity?

Possibly some of the readers of this magazine can give an explanation of the phenomenon that will really explain. To say that the plant cells are *hungry* for the lumic energy necessary for the splitting of the molecules of carbon dioxide, so that they may, through the agency of the chloroplastids, feed on the atom of carbon in CO_2, building up the highly complex substance called starch, and are thus naturally heliotactic—is to state a fact rather than to explain it. Undoubtedly electronic forces are at work in the process, and somehow force the cells lightward; but how?

Leibnitz long ago pointed out that force, or the exhibition of energy, is the most important and fundamental phenomenon in the universe. That force we now know to be electric energy; but we do not yet know what electric energy is. We do know, however, to a certain extent, the conditions under which it becomes manifest to man's senses, and how it can be harnessed for man's uses. But we do not know how it is harnessed and utilized for the plant's uses. The energy hidden in the cell of a living plant, enabling it to convert the inorganic into the organic—into that enormously complex material represented by the formula $C_6H_{10}O_5$ —is at present quite beyond man's comprehension.

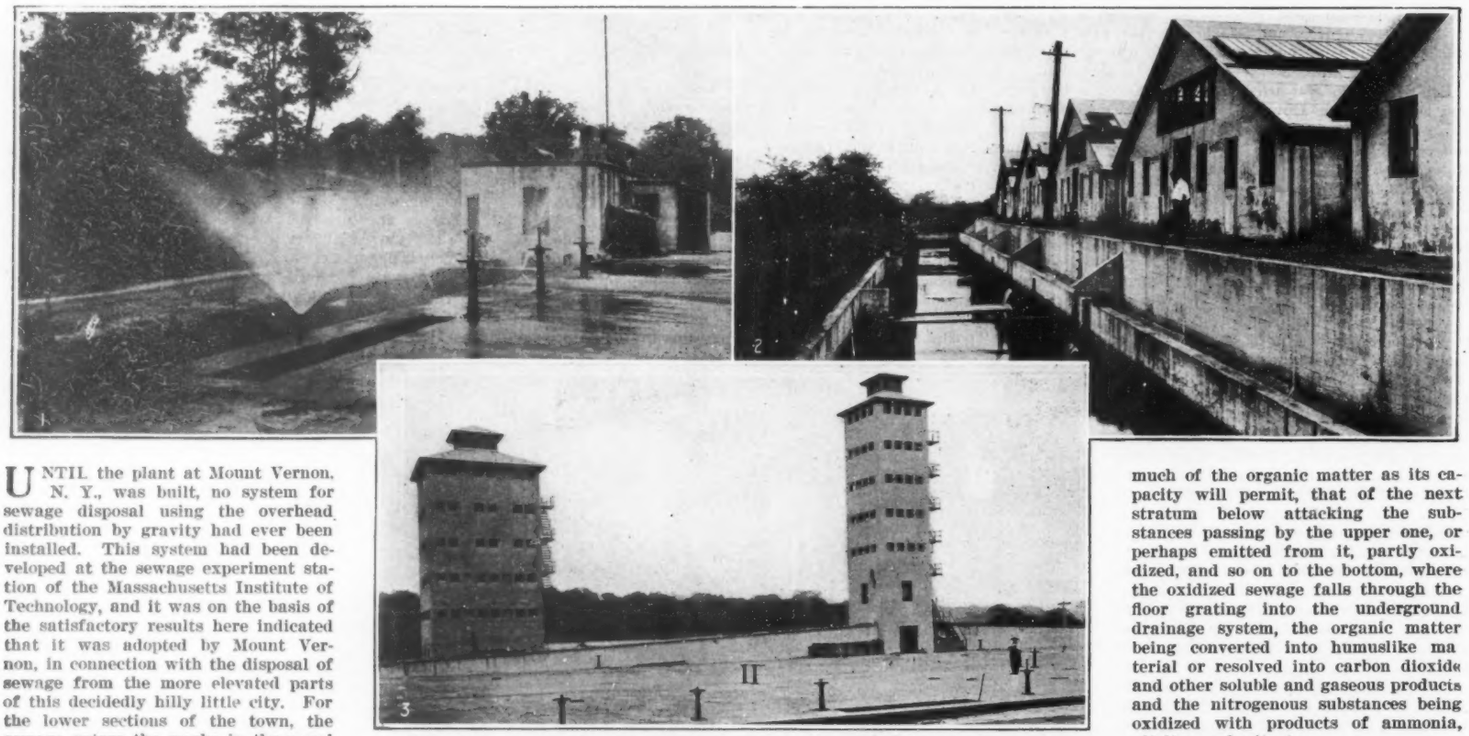
Fire-Proofing Cotton

A PROCESS has been devised for treating baled cotton with a chemical compound which renders it flame and spark proof and at the same time apparently provides an inch or two of cotton in condition to aid in rapid drying without deterioration in case a bale is exposed to weather. On an average, 20,000 bales of cotton are destroyed by fire before the crop is marketed and most of this loss can be traced to flash or spark fire. Cotton stored in suitable warehouses would be evidence of a progressive step, for there is probably no crop of so great value that is treated with so little thoughtful consideration.

Disposing of the Sewage

A Typical Plant at Mount Vernon, N. Y., with Special Features of Interest in Overhead Distribution

By Sanford G. Plumb



1. Water test of the nozzle and inverted spraying disk for underflow distribution. 2. Rear view of filter bed sheds and tank discharging oxidized effluent into the river. 3. Overhead gravity distribution, with streams of sewage falling on spraying disks

How Mount Vernon takes care of its sewage to such good effect that it does not seriously pollute the river into which it is discharged

UNTIL the plant at Mount Vernon, N. Y., was built, no system for sewage disposal using the overhead distribution by gravity had ever been installed. This system had been developed at the sewage experiment station of the Massachusetts Institute of Technology, and it was on the basis of the satisfactory results here indicated that it was adopted by Mount Vernon, in connection with the disposal of sewage from the more elevated parts of this decidedly hilly little city. For the lower sections of the town, the sewage enters the works in the usual fashion, 26 feet below the level of the screen chamber and septic tank, and is brought up to that level by two electrically operated pumps of 25 horsepower each. The total volume thus handled is 1,000,000 gallons; to this the gravity system adds 1,500,000 gallons. The combined mass flows through the screen chamber and septic tank to the overhead distributing system of pipes above the filter beds.

On the satisfactory results obtained at Mount Vernon has hinged the adoption of this system of sewage distribution in several other cities; and for this reason the Mount Vernon plant is the scene of frequent inspections by officials from other States. The plant has been in successful operation eleven years, which should be sufficient to establish the principle as a sound one.

As an introduction to the subject, we may say something of the theory of sewage disposal by trickling, borrowing the subject matter from Metcalf and Eddy on Disposal of Sewage. Liquefaction, the change of insoluble substances into soluble ones, has been described as a result of bacterial activity through enzymes. Certain species of bacteria appear to liquefy in a much greater measure than others; the aerobic bacteria are reinforced by enzymes. The process of oxidation of free ammonia, first to nitrites and then from nitrites to nitrates by separate and distinct organisms, is called nitrification. That nitrification is due to bacterial action is apparent from the fact that it is checked or stopped entirely by low temperature, by heating to the point of sterilization, and by certain chemicals inimical to the life of bacteria. Furthermore, temperatures favorable to bacterial development cause nitrification to proceed rapidly.

While some enzymes have been known for years, even before the organisms secreting them were known, there is still no knowledge of their chemical composition. They possess the peculiar property of not being destroyed by the process in which they take part. Like the organisms which secrete them, they are sensitive to heat and poisons, becoming inactive on exposure to temperatures about 50 degrees to 80 degrees C. and to disinfectants, like formaldehyde and mercurial chloride. The final decomposition, the process which yields the energy for cell life, must take place within the cell. Investigations of recent years demonstrate that these processes are caused by enzymes.

The trickling filter is capable of converting putrescible settled sewage into stable effluent, not subject to putrefaction under the most exacting conditions. In trickling filter-beds, the sewage is applied to the surface as uniformly as possible by sprinklers or other devices. Experience has demonstrated that usually the trickling filter-beds are self-cleansing.

The settling solids not removed by preliminary sedimentation are retained mechanically in the pores of the filters. The colloidal matter adheres to the surfaces through attraction and absorption and the dissolved organic matter is absorbed by the bacterial jelly or acted upon directly, probably both processes occurring. The bacterial jelly coats the stones from top to bottom of the bed, in mature condition, and appears to perform its functions in relays, that at the top acting upon so much of the organic matter as its capacity will permit, that of the next stratum below attacking the substances passing by the upper one, or perhaps emitted from it, partly oxidized, and so on to the bottom, where the oxidized sewage falls through the floor grating into the underground drainage system, the organic matter being converted into humuslike material or resolved into carbon dioxide and other soluble and gaseous products and the nitrogenous substances being oxidized with products of ammonia, nitrites and nitrates.

Knowledge of the particular organisms present and the work which each species does is lacking, but it is certain that the processes are chiefly aerobic, for failure to supply air is quickly reflected in the inferior quality of the effluent.

The periodic storage and disgorging of solids by the trickling filter is one of its most important and interesting features. When sewage first reaches the public sewers, it is "fresh" and contains free oxygen, so that aerobic bacteria thrive. The bacterial activity rapidly depletes the oxygen, which may become exhausted, as sewage, unless vigorously agitated, absorbs oxygen from the atmosphere very slowly. After a lengthy flow through sewers, aerobic bacteria, though present, are fast losing their activity. Such sewage is classed as "stale" and at the same time the faculative anaerobes begin to increase in number and activity.

The depletion of oxygen is particularly marked if the sewers are of such length that several hours elapse before the major part of the sewage reaches the outlet. Soon the last traces of oxygen disappear, the sewage becomes very dark, or even black, and hydrogen sulfide or other sulfides are formed.

When sewage stands for a long time or flows very slowly through tanks, the anaerobic organisms gain the ascendency and ammonia, marsh gas, carbon dioxide, hydrogen, nitrogen and other gases may be formed, as the complex organic compounds are broken down into simpler ones. This is a reduction or septic process.

While oxidation goes on to some extent during anaerobation, it is usual to consider aerobic conditions essential to oxidation which approaches completeness. Oxidation of organic matter is effected by many aerobes, including those producing nitrites and nitrates.

It will be deduced from the generally accepted theory so concisely expounded in the foregoing extracts not only that an even distribution of the liquefied sewage over the surfaces of the filter-bed is essential so as not to flood the interstices, but that it needs to be violently agitated to renew the supply of oxygen by aeration; hence the importance and signifi-

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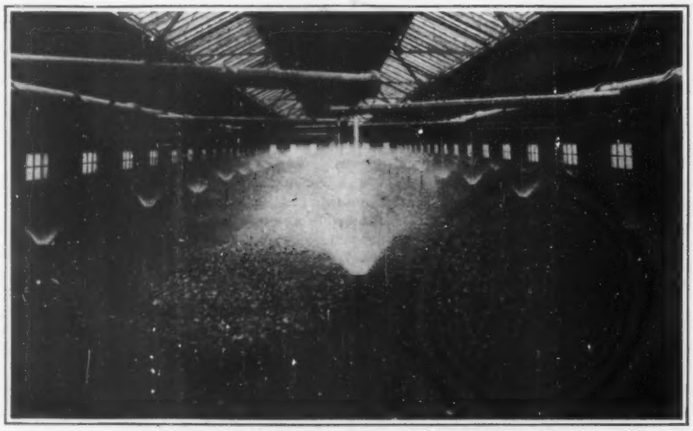


Spraying the sewage over the filtration bed

A New Type of Torpedo Boat

IT is an interesting study to trace the profound changes which important successive engineering developments have produced in the design of naval ships, changes which in some cases have been distinctly of a revolutionary kind. Particularly is this true of motive power. The advent of the practical marine steam engine stripped the fighting ship of its towering fabric of masts and sails, and so greatly increased the maneuvering power and speed of the warship that the picturesque frigate and three-decker disappeared from the seas forever.

Similar in kind, though not in degree, are the changes which have been wrought by the introduction of the internal combustion motor and the use of oil fuel. As steam power reduced the visibility and increased the speed of warships, so oil fuel and the oil engine are reducing the visibility of warships by getting rid of telltale smoke and rendering possible a marked increase of speed in the larger ships and a phenomenal increase of speed in the smaller craft.

It was only a question of time when the high-speed motor boat would begin to attract the attention of the naval designer and lead him to seek some way in which he could utilize in naval craft the astonishing speeds achieved by this type of boat. The official speed of 70 miles an hour, maintained by "Miss America," in the recent contests for the Harnsworth cup, was the culmination of motor boat speed, which had been advancing by leaps and bounds during the past ten years; and it was inevitable that a serious effort would be made to utilize a modified form of motor boat in those fields of naval warfare in which a combination of invisibility and high speed is of prime importance.

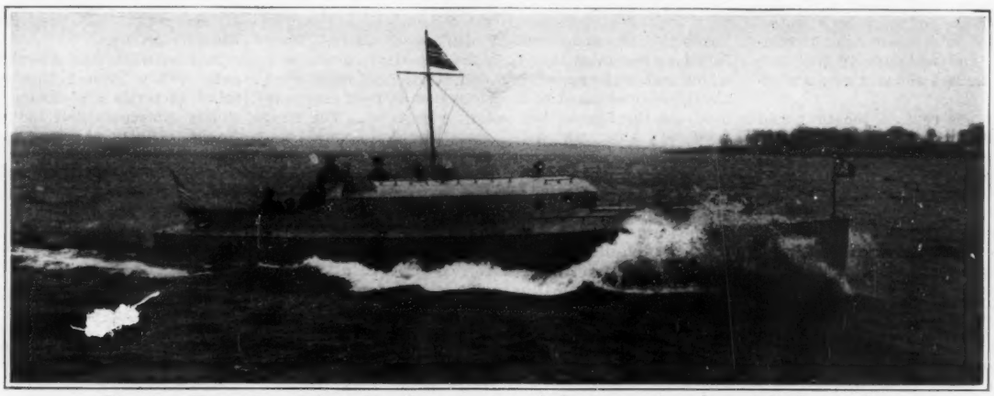
The accompanying illustrations represent a most promising effort in this direction. The boat is the product of civilian effort, and it is the third of its type to be built by its inventor, Mr. W. B. Shearer of this city. One of these illustrations was taken a few minutes after the boat had been christened by the wife of the inventor and launched on the Sound at City Island, in the presence of a party of guests consisting mainly of ranking officers of the Army and Navy. As soon as the little craft was clear of the ways, the engines were started and she went through a number of evolutions at speeds of 15 to 20 miles an hour. Because of the fact that the engines were new, no attempt was made on these tests to reach the maximum speed of 32 miles an hour. The dimensions of the boat are—length 58 feet and beam 9½ feet. The twin engines develop 600 horse-power. The "Sea Hornet," as she is called, was designed to meet the conditions which the inventor considers to be indispensable for successful torpedo attacks, namely, small size, invisibility, high speed of approach and retreat, and mass attack.

In spite of the high stage of development to which the torpedo has been brought, and the great range which the latest types can cover, the experience of the late war has shown that to hit a ship at ranges of 7,000 yards and over is more a matter of luck than good shooting. In the great battle of Jutland, torpedoes were discharged by the hundreds; but the percentage of hits was exceedingly small. The explanation is to be found in the impossibility of close approach by destroyers, because of the destructive fire of the heavy anti-torpedo batteries carried by the modern battleship. To make sure of a hit, torpedo craft should approach to within 1,000 or 2,000 yards range, something which is impossible for the modern destroyer, which is a big ship, 1,200 to 1,500 tons in displacement and over 300 feet in length.

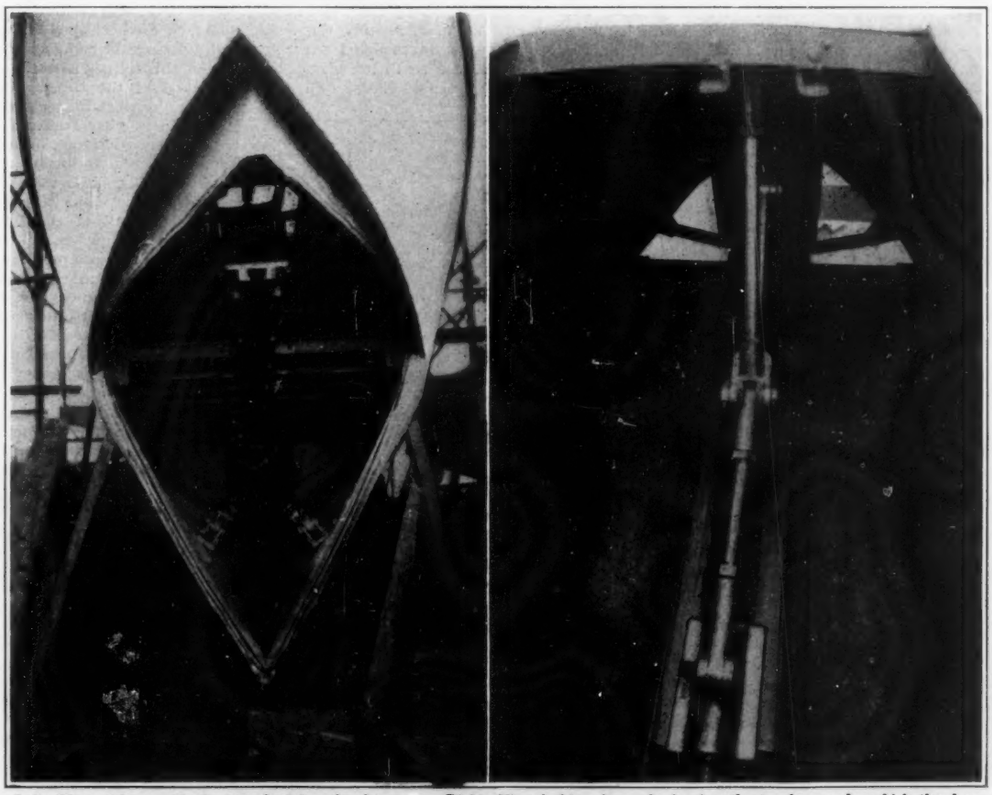
The "Hornet" with its speed of 30 knots and over would make its rush for the enemy end on and in great numbers (it can be built for $30,000 to $40,000), and so low do the craft lie in the water, and so great would be the change of range as they approached, that it would be impossible for the gunners on the enemy ship to change and set their sights quickly enough to make sure of a hit. Even were a barrage laid down, the boats would be so quickly through it that the chances of disablement would be small.

A remarkable fact in connection with these little craft is that they can carry three of the largest 21-inch torpedoes, which are carried upon bronze rollers bolted to the floor of the boat. The first torpedo is carried in the firing chamber at the bow; the second is below and between the twin engines; and the third below the deck of the cockpit, each being in its own separate watertight compartment. In firing, a large valve is opened and the bow compartment is flooded. By means of a threaded shaft connected to a powerful toggle gear, the lower half of the bow swings up and back and houses within the boat. The starting lever of the torpedo engines is then tripped, and the torpedo leaves the bow under its own power. Two powerful pumps then clear the firing chamber of water, and the second torpedo is pushed forward into the chamber ready for a second attack.

Motor torpedo boats open up a wide field for the use of the torpedo. They can be carried on special motor-boat ships corresponding in size and speed to airplane carriers, which would accompany the main fleet, the boats being launched for mass attacks on the enemy's battle line. They would form a valuable auxiliary to our coast defenses. As matters now stand, a great increase in the range of naval guns has put the larger part of the artillery of our coast defenses at a serious disadvantage. When these fortifications were designed and equipped, naval ranges were less than one-half what they are today; and it would be possible for a fleet of modern ships to lie at a range entirely beyond the reach of a large portion of our shore batteries, and bombard them without the batteries being able to make any reply. It is considered that the maintenance of flotillas of these motor torpedo boats at or near our principal coast fortifications would effectively prevent any such long-range bombardment, since they would effectually break up the enemy's line and render it impossible to carry out any accurate and sustained attack.



The "Sea Hornet," a 58-foot, 30-mile motor torpedo boat, carrying three 21-inch torpedoes



Left: View of bow, with the torpedo firing chamber open. *Right:* View looking forward, showing the toggle gear by which the door of the firing chamber is opened when firing the torpedoes

Details of the torpedo-firing mechanism of the motor torpedo boat "Sea Hornet"

An Explanation of Leaning Chimneys

BETWEEN the wagon builder, alternately wetting and drying a board to bend it to the desired shape, and the house chimney, grotesquely leaning toward the east, brick masons say there is similarity. The leaning chimney is a subject on which even the doctors disagree, but the theory referred to seems the most plausible.

Chimneys lean toward the east. A little observation anywhere will prove this. Even the best-built affair of brick and mortar, acquiring age, often begins to lean. Various theories are advanced, but the explanation of alternate wetting and drying seems the best.

Chimney walls collect more or less moisture during the night, on all sides. Now if the broad side of the chimney is toward the east, and if the sun strikes that part of the chimney first, as it will, that side dries out much quicker than the north or south side, or the western side. In time of rainfall, the east side ordinarily is dried the quickest. This general condition has the effect of pulling the chimney toward the east.

A New American Industry

How the Making of Toys Has Been Established on a Solid Basis in This Country

By Harry A. Mount

WITH foreign-made toys again available to American buyers and prejudice against the "Made in Germany" mark fast disappearing, what is to become of the American industry which sprang up overnight in 1914? For the first time since the war our toy makers are beginning to feel the effects of competition. Several of the mushroom concerns already have been forced out of business. But the industry as a whole, investigation reveals, is well intrenched against competition from foreign lands and undoubtedly will survive its crucial test. The war has added a new American industry.

Before 1914 about ninety per cent of the toys sold in the United States were made in foreign lands. The ten per cent of American toys sold were, as a whole, an inferior product. Toy sellers thought of games in terms of Spear, the one great German toy house. The highly colored and exquisitely finished German games had no American rival. The finest dolls came from Germany and France and mechanical toys were almost certain to bear the German trade-mark.

Today our games are as good as any that came from Spear; we are making better dolls than ever came from abroad; and our mechanical toys are far superior to the foreign product. It was once the habit of American toy-buyers to make a mid-summer trip to Europe to order toys for the holiday trade. For the last five years these junket trips have been cut off. Undoubtedly much of the foreign ordering now is being done by buyers who are more anxious to see battle-scarred Europe than to find better toys than they can secure at home. But American manufacturers are not asleep. They are already shipping thousands of dollars worth of American toys to Latin-America, which once was supplied almost entirely by Germany. They are even selling toys in England and France and at least one firm is shipping dolls to Berlin.

But why are American toys the best in the world today?

The toy industry naturally falls into three distinct divisions and it will be necessary to consider each independently. The largest-selling toy line is dolls. That is because dolls, as miniature reproductions of our own selves, have the most universal appeal. Every girl must have her family of dolls, but boys too play with them and even men and women buy thousands of dollars worth of novelty dolls each year.

The first requisite of a good doll is a beautiful face, with the texture and fine coloring of a real head. German bisque heads came nearest to perfection in former days and bisque dolls were standard. When the supply of German dolls was suddenly cut off there was a demand for dolls which existing American manufacturers could not begin to supply. As a result small cloak and suit makers and a variety of similar manufacturers turned their establishments into doll factories. They made very creditable cloth bodies but in attempting to supply heads the American makers "fell down" flatly. They failed to recognize that it is the beautiful child's face which makes the appeal in a doll. Artists of indifferent ability were engaged to model the heads, poor clay was used for the bisque, bad colors were used. The first flood of American dolls was therefore very disappointing.

But out of some 125 doll factories that sprung up to meet this new demand, a few have recognized that doll making is a fine art and their success more than compensates for the first poor results. German practice has been discarded and the doll you buy today for your little girl is a thoroughly American little miss. Her head is not of brittle bisque but is of a non-breakable composition. The texture of the finish and the coloring, however, are just as fine as that of the German bisque. The bodies are of the same material or are of cloth stuffed with ground cork, but in either case they are more substantial and better made than the imported bodies. Both bodies and head have been designed by the best artists to be found. The faces no longer present the blank, staring "baby-doll" look, but real character is graven in them. Probably the best selling doll in the world today is modeled after a famous cartoonist's conception of a real little girl. She doesn't wear just a one-piece dress of cheesecloth, but her clothes are designed and made just as carefully as if she were a real little girl.

There are several compositions and processes for making dolls but the one most widely adopted consists of pressing a mixture of sawdust, resin and glue into hot molds producing half of the head or body. The two halves are then glued together, baked, trimmed, dipped in specially prepared enamels and finally finished by artists.

And so while the American doll makers are apparently losing ground just now because many of the small factories are closing, the foundation for a distinctly American doll industry has been laid and no foreign country at present is able to compete with the product.

Next to dolls in appeal in the toy line are the games. Two or three American game makers have been long established, but it must be frankly admitted that their product had failed to reach the degree of excellence obtainable from foreign makers.

These factories have doubled and tripled their output since 1914. But they have done more than that. They have been searching for better manufacturing methods, better colors, better materials, better designs and as a result their product is just as good today as the finest to be obtained elsewhere. Added to this are American methods of quantity manufacture so that in the United States our game manufacturers have every advantage over foreign competitors. There seems little chance that American games will ever be superseded where they have gained a foothold and their selling range is being constantly widened.

The third line, mechanical toys, is most firmly established of the three. The foreign-made toys were brightly colored and finely finished, but very frail. The mechanisms were poorly designed and once broken they could seldom be repaired because parts had to come across the sea.

Take toy trains, for instance. Nearly all of these were imported before 1914. Now there are two American makers whose products have come to be the world standard. Not only are the trains they produce just as finely finished as any others, but they are built with the precision of real trains, with well-designed and robust mechanism. Parts for these trains are quickly available.

Sheet-metal toys which formerly were made in Germany have been re-designed and the American-made toys look just as well and are much stronger. Yankee

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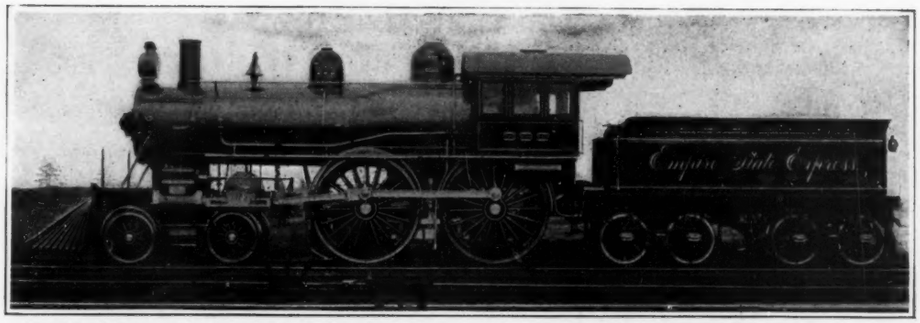
1. The hot molding machine for making doll parts. 2. The fabrication of doll's heads. The man at the right is dipping the heads; the one at the left is air-brushing on the pink cheeks. 3. Stuffing cloth bodies with their ground cork filling

The manufacture of dolls in great numbers as it is being carried on in America today

Old 999 Still in Service

By Ralph Howard

CONSIDERABLE circulation was given, recently, to a statement that No. 999, the famous engine that hauled the Empire State Express for so many years had been sent to the Port of Missing Engines, otherwise known as the scrap heap. This is not in accordance with the facts, for the famous locomotive is still in service on the railroad that it helped to make famous. In this connection the New York Central has supplied us with material on the history of the old engine, which many readers will find of great interest.



Engine 999 as she appeared in her heyday, when she hauled the Empire State Express at a net running speed of sixty miles per hour

No. 999 was built entirely at the construction shops of the railroad in West Albany. She was completed in 1892, and went into regular service in front of the Empire State Express early the next year. Built for light, fast running, she was ideal for this light, fast train. She was equipped with special 81-inch drivers and 40-inch truck wheels, and was the first engine to have brakes applied to her front trucks. It was with her doing the hauling that the train made its much disputed record of 112.5 miles per hour. The scheduled time for the 439 miles run between New York and Buffalo was eight hours, with four stops. Deducting all stops, etc., the schedule called for a net speed throughout the run of just about sixty miles per hour. Owing to heavy traffic and other conditions, these exacting demands on the Empire have been modified, and her schedule now allows her nine hours to make the run.

It is to be emphasized that, while engines today are built much heavier than the 999, their drivers are not so large. This puts them at a double disadvantage when it comes to a question of pure speed; for not only must a greater piston speed be developed to cover the ground at the same rate, but the pounding on the track is vastly greater. The engines of today will make their maximum speed with a far longer and heavier train than their predecessors of twenty years ago—the 999 would not begin to make 60 miles per hour with nine or ten cars; they would make just about as good speed as the old fellows did, in fact, if the track were such as to permit it; but if we attempted to run the Empire State Express of today at any such speed as 100 or 110 miles per hour, the first curve would probably see her ditched by spreading rails. Her limit is about 80 or 85 miles on the straightaways.

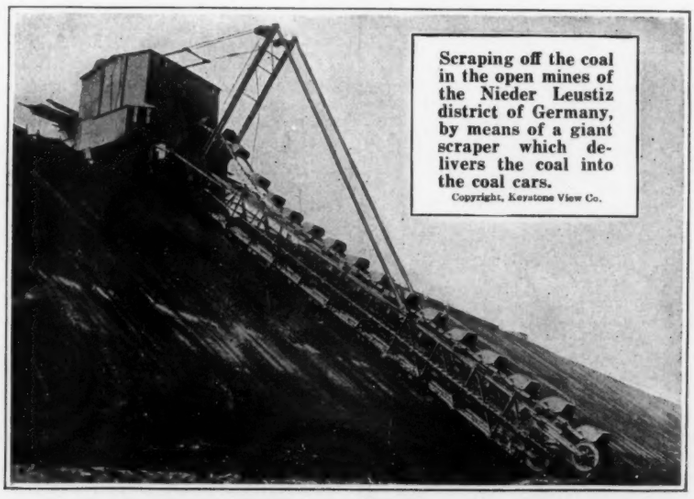
After about twenty years of service of the sort for which it was built, it became necessary to retire the 999 from the main line, in recognition of the length and weight of the through trains of the new period. The famous engine was therefore shifted to the Rome, Watertown and Ogdensburg, then maintaining its operating organization more or less distinct from the big line but now known merely as the St. Lawrence Division. In 1913, after considerable alteration, her number was changed to 1086. Soon after she was shifted to the Pennsylvania Division, where she has been employed ever since, and where she is now rounding out her twenty-ninth year of active passenger service.

A glance at the record card of the old locomotive is of interest. It appears that her original cost was a mere $13,000, and that in the last thirteen years of her career she has been the beneficiary of thirteen more or less general overhaulings at a cost of some $14,000 more. This phase of her record cannot be given for her complete career, since repair sheets prior to 1908 are not accessible. The time when the famous old locomotive is no longer available for service is remote, but when it arrives, plans already under consideration will insure her an honorable post of retirement and exhibition in the Grand Central Terminal at New York. This will be a fitting terminus to the history of an engine that has contributed so largely to the railroad lore of the United States.

The 999, made over somewhat and with her number changed, as she appears today in passenger service on the Pennsylvania Division of the New York Central Lines

Coal Mining in the Open Mines of Germany

COAL generally calls up a vision of dusky miners working far down in the bowels of the earth, laboring hour after hour in cramped quarters and faced with all sorts of danger. So the accompanying view of the activities at the open mines of the Nieder Leusitz district of Germany is of more than passing interest, because it shows one phase of coal mining that is utterly different from the accepted version—as different from conventional coal operations as the iron mining of Michigan is distinct in its field.



Scraping off the coal in the open mines of the Nieder Leustiz district of Germany, by means of a giant scraper which delivers the coal into the coal cars.

Copyright, Keystone View Co.

These barren coal mines of Germany make mining a simple matter. By means of shovels of the type here shown, the coal and admixture of dirt is scraped off the surface and loaded directly into coal cars on top of the embankment. These cars transport the coal and dirt to the plant where the larger coal is sorted out from the similar pieces and the dust, the latter being compressed into briquets.

The Properties and Uses of Manjak

THE term "manjak" is applied to a variety of bitumen or solid hydrocarbon occurring on the Island of Barbados, and in Utah, Cuba, and Trinidad. The deposits on the latter island are found within a distance of three miles of San Fernando, the second largest town on the island, and within three miles of the famous asphalt lake.

In chemical composition, manjak is like asphalt. It is almost pure bitumen. Its melting point is, however, more than 400° Fahrenheit, whereas asphalt melts at 100°. In composition, it consists of 80 to 90 per cent carbon, the balance being chiefly hydrogen, with a small quantity of sulfur. It resembles coal in appearance, is odorless, hard, and brittle. It is found in thin beds between layers of clay.

The island of Trinidad is rich in this mineral resource. Its development has as yet hardly begun, and the exportations already made have been with the view of testing out the material. During 1918, exports to the United States were valued at about $3,100, and in 1919, up to October 1, they totaled 41 tons, valued at $1,900. Prior to 1900, manjak was mined on a small scale in Trinidad, but for various reasons, very little was done between 1900 and 1913. In the latter year, mining operations were resumed, and at the present time there are five shafts, one of which has reached a 37-foot bed of manjak at a depth of 400 feet. Operations could be greatly extended if there were a greater demand for the material.

It has not been found profitable to export manjak from Trinidad in the crude state as the price received, namely, $35 per ton, hardly covers mining expenses. These are increased by the necessity for careful and thorough timbering on account of the clay formation.

Compounds, made by combining manjak with mineral oil, command fair local prices which have enabled mine operations to proceed at a profit. Experimentation is still in progress with different mixtures of manjak and oil for various purposes. The manjak recently sent to the United States was for the purpose of ascertaining whether American oils would be more economical and useful for mixing with the manjak than the Trinidad oils. It is the plan to erect a plant very soon for the manufacture of manjak paints and compounds.

Manjak is rapidly increasing in use, according to the U. S. Bureau of Mines, particularly in connection with the oil industry. It is produced in close proximity to the oil wells in Trinidad. It is boiled with oils at high temperatures and converted into compounds and paints for nearly every purpose where a preservative is needed, for example, on pipe lines, boilers, chimneys, and miscellaneous iron ware, machinery, etc. It is usually applied in the liquid state, hardening into a tough, rubberlike coating. It has low viscosity, and is not affected by ordinary heat. It makes an excellent insulating material and is impervious to both air and water. In hot and damp climates, like that of Trinidad where pipe lines quickly deteriorate, their life has been prolonged for extended periods when painted with this material.

The most important use of manjak, and one wherein it has won a reputation for saving money, is in connection with rotary drilling for oil. A soft compound is used on the joints of the pipes between the casting threads and drill stem threads, and this prevents either water, sand, or grit getting into the threads, thus preserving them from being stripped or worn off. It not only acts with partic-

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With the Engineers of Industry

A Department Devoted to the Physical Problems of the Plant Executive

This department is devoted to business men, works managers, production engineers, and all other executives seeking the maximum efficiency in carrying on their work. The editor of this department will endeavor to answer all questions relating to plant equipment, factory management, and industrial affairs in general.

Ventilation Made to Order

IN keeping with the steady trend toward specialization in all the arts and sciences, ventilation has become a highly specialized branch of engineering. And happily so; for the subject of ventilation is one of vital importance where the general health of the workers and their general efficiency are matters of prime consideration.

Time was when ventilation was merely a matter of opening the windows and doors more or less to admit the necessary amount of air from the outside. During extremely cold weather the windows and doors were kept tightly closed, because the admission of fresh air also meant the admission of cold. As a consequence the air in such plants became quite vitiated in the course of the working day, and the workmen became drowsy, careless and inefficient. It was inevitable.

Perhaps the best proof of the value of proper ventilation is to be found in our modern theaters, where ventilating systems handle a tremendous amount of fresh air while the shows are in progress. In one of the recent installations of this sort, in a theater seating 5,500 persons, the air is changed every few minutes. Huge blowers take in fresh air and pass it down through the outlets in the ceiling and under the balconies, while smaller outlets scattered about the floor line remove the foul air. During winter months the air is heated by passing it through steam coils, while in summer the volume of air is considerably augmented so as to lower the temperature within the theater. By exhausting somewhat less than the amount of incoming air, it is possible in cold weather to build up a static pressure, so that when doors are opened there is absolutely no rush of air into the room. In some instances something like 75 per cent of the air is exhausted through the regular outlets, leaving an excess of 25 per cent which percolates through doors and other openings and prevents draughts.

The ventilating systems now being installed in various kinds of buildings are worthy of serious consideration, since they make for the utmost efficiency. For one thing, most ventilating systems may be made to heat the largest room by passing the air through heating coils. This method of heating is highly efficient, since it keeps the heat in constant circulation. All in all, the subject of ventilation is an important one and should be considered. But before taking any action in this direction the plant executive should first consult the engineering department of the various manufacturers of blowers and other ventilating equipment. Remember, they are specialists!

The Value of Clean Floors

IN a previous issue we had something to say about clean walls and their effect upon the morale of the workers. Now we have something to say about clean floors, which also react on the morale of the workers. Furthermore, clean floors have a certain advertising value in such plants as welcome visitors. Nothing makes for an impression of efficiency and pride in self and in product as does a clean floor.

To the end of simplifying the scrubbing of large floor areas, especially the concrete, stone or tile floors of the factory, office, theater entrance or hotel lobby, a number of electrically-operated scrubbing machines have been placed on the market during the past few years. These machines are all of a more or less similar design, consisting of a fractional horse-power motor driving an arrangement of stiff brushes in contact with the floor, and storage tanks for soap and water. A reel mounted on the wheeled cart carrying the scrubbing equipment, pays out wire as the scrubber is pushed over the floor. Any workman can scrub a large area of floor space in a short space of time with the electric scrubber. The physical exertion is practically nil. Furthermore, the scrubber produces a better job and more uniform work than can ever be done by the manual method of scrubbing. And it goes without saying that the cost is far below that of the back-breaking method.

Whether or not to use an electric floor scrubber is merely a question of the amount of scrubbing to be done. Just as it would not pay a gardener to use a gasoline tractor for cultivating his flower beds, so it would not pay anyone to use an electric scrubber in a small shop, store, office or other place. It is a question of volume of scrubbing.

The Steel Fence Investment and Its Returns

THE day of the wooden fence about the plant is gone. Wooden fences have outlived their usefulness. They never were highly satisfactory, but for want of something better they continued in use until the advent of the present steel-post, wire-netting and barbed-wire fences.

The various systems of steel fencing are more or less designed along the same general lines. They consist of various styles of steel posts which are set directly in the ground or are imbedded in concrete, and stout steel netting. Fences of this kind protect the plant against trespassers, thieves, firebugs, and other undesirables. Indeed, the steel fence is so secure that it virtually extends the storage space of the plant buildings beyond their walls, since the yard becomes just as secure as the store rooms, as far as theft and fire are concerned. It also protects the workmen against accident by preventing their crossing dangerous railroad tracks, taking reckless short-cuts, and so on. It simplifies the handling of workmen, since it limits their entry and departure from the works to certain definite gates. All in all, the steel fence marks a big step forward in plant efficiency, both from within and without.

Motor Drive for Operating Sashes

THE large number of sash units to be handled in many of our plant buildings has caused the introduction of motor-operated devices. The "runs" that are handled by the electric motor installation may be as great as 600 feet, consisting of a system of shafting, cables, rods and arms, counterweights and spirals, actuated by a single motor.

One system of sash operation which has met with wide favor makes use of counterweights and spirals, acting through the transmission rods and supporting the weight of the sash when open, thereby relieving the worm gearing and motors of that load. By requiring the motors only to overcome friction (and that a minimum), from 500 to 600 feet of 6-foot sash can be operated with one smaller motor. Without the spirals and counterweights, claim the designers of this system, four motors would be necessary here; or the motors would have to be much larger. Another advantage of this particular system is the uniformity of the load. Adding a spiral and counterweight makes it easy for the motor to restart the sash when stopped partly open, and gives uniform operating conditions, including speed and wear, for all points from shut to open.

Some Gasoline Precautions

IN gasoline engine installations and where gasoline is stored, it is almost impossible to prevent slight leaks in the gasoline system, causing the oil to leak out and gasoline vapor to be formed in greater or less quantities. This alone will cause gasoline vapors to be present more or less continuously, especially in the lower spaces under subfloors, floor plates, etc. The danger of the spark necessary for the explosion is always existent and cannot be wholly eradicated. Under these conditions it is of the utmost importance to prevent the accumulation of the vapor in sufficient quantities to form an explosive mixture.

According to A. S. Baker, Plant Protection, Philadelphia Navy Yard, writing in *Safety News*, this can be done by proper ventilation, which can be accomplished by the installation of suction fans near the floor, or between the floor and the sub-floor if any exists. This fan should be run at least one hour daily and in addition at such other times as the presence of gasoline vapor is suspected or is liable to accumulate. In the small private garage, a small space cut out at the base on both sides will be sufficient to carry off this vapor.

In addition to the above, gasoline should not be used for cleaning in enclosed spaces if its use can be avoided. Take the articles to be cleaned to the open air and clean them there. However, where it is necessary to use gasoline or gasoline rags for cleaning in enclosed spaces, use only small quantities in a stoppered container, and see that the smallest possible amount is exposed to the air at one time. Also have as much ventilation in the room as is possible. Avoid rubbing or striking objects liable to generate a spark or static electricity. A good plan is to shut down all electric appliances or machinery in operation in the vicinity. Prohibit all open flames of any description in the immediate or near vicinity. Oily waste or rags should at all times be placed in a safe receptacle to avoid danger of spontaneous combustion. Empty gasoline containers should be filled with water and stored in safe places in the open air.

To extinguish a gasoline fire, one of the several leading types of fire extinguishers should be used. Sand may also be used if available, as well as a mixture of sawdust and bicarbonate of soda; even a wet blanket may be used in the case of a small fire, to smother it. Water should not be used, as the gasoline will float and the only result will be to spread the extent of the fire. There is, however, one case in which water may be used to advantage, viz.: Where gasoline floating on the surface of a stream becomes ignited, hose streams may be used simply as brooms to sweep the flames away from docks, boats at anchor or tied up at the piers, or buildings along the water's edge, which may be endangered.

Soot and the Boiler

ANYWHERE from 4 to 10 per cent of the fuel used under a boiler in the usual way may be saved by the use of soot blowers, according to fuel engineers. When soot accumulates on the heating surface of a boiler, it builds up a greater or less layer of heat insulation between the boiler and the fire, thereby diminishing the efficiency of the fuel to just that extent. For it is obvious that a large part of the heat is lost because it is not transmitted to the water; and this means excessively high coal bills, and poor, uncertain service from the boiler. Obviously, too, high efficiency in the generation of steam is dependent upon the maintenance of the cleanest of clean heating surfaces.

A hand lance is often employed to clean the soot from the boiler's heating surface, but this method is a relic of past days of relative inefficiency. Such a method is all well and good in the case of small boilers, where the saving effected by an automatic installation would hardly offset the cost within a reasonable period of time. But in larger boilers the soot blower means a material saving in fuel costs, in some instances as high as 10 per cent.

Keeping the Sprinkler System from Freezing

SPRINKLER systems should always be in good working order, ready at a moment's notice to protect lives and property against the ravages of fire. Under no circumstances should the water supply for the sprinkler system be allowed to freeze, for that defeats the entire purpose of such an installation at a time when fire risks are perhaps greatest.

It has remained for a manufacturer of water heaters to develop a satisfactory method of preventing the freezing of sprinkler systems. A multi-copper-coil gas water heater attached to the standpipe of any sprinkler system is said to make the latter absolutely freeze-proof. All through the long winter months it will automatically control the temperature of the water and keep it above the freezing point. The same system of heating may also be used for providing hot water for factory lavatories.

Faster Rehandling with Less Labor

A HAND-OPERATED hoist is the means of effecting a material saving in rehandling costs, but an electric hoist effects just as great a saving again over the hand-operated type. Small electric hoists are finding wide application in many plants, both indoors and outdoors, where they are reducing to a minimum the cost of the necessary, but usually unproductive, item of rehandling. Electric hoists are generally mounted on wheels which travel on overhead rails. Two rope controls are provided, one for lifting and the other for lowering.

The latest German art — trimming shrubs to represent animals

A Sculptor in Shrubbery

THE people of Germany are turning from war to art and pleasure. Their new art, with which we are particularly interested in this case, takes various forms such as exceptional publicity methods, odd store fronts, remarkable architecture, and bizarre landscape gardening.

The German gardener depicted in the accompanying illustration specializes in hedges surrounding large estates. He trims the shrubs in various ways so as to represent men, animals, geometrical figures, and so on. Obviously, this work calls for no mean ability in the manipulation of the shears not to mention an artistic temperament of a more or less creative type.

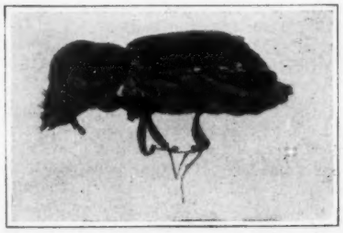
It should not be believed that the Germeans have invented anything new, as the art is quite old in England where it is known as the "topiary art," and whole books have been devoted to it.—By *A. M. Krumm.*

A simple ladder for climbing up to the bulb of a lamp post

The "Short-Circuit" Bug of California

A WOOD boring beetle in California has found out a new way to add to the grief of the poor telephone girl. *Scobicia declivis*, for that is his only name, bores right through wood and alloyed substances which are considerably harder than lead. By boring holes in telephone cables he is putting hundreds of telephones out of commission; for when a chance rain comes along the water gets in the holes and right away somebody has a job trying to find out where the beetle has been working again.

The damage most always occurs where the cable is in contact with the ring by which it is suspended. Experimental work is being carried on with various types of suspension rings, lead alloys and chemical substances to cover the lead sheathing in order to prevent the ravages of the beetle. No practical method of control has been found yet.—By *Allen P. Child.*



The "short-circuit" bug of California, magnified about 7 diameters

A Ladder for the Outdoor Lamp Inspector

AN inspector employed by the Harbor Board at San Francisco has devised a light ladder that he uses in climbing the lampposts along the water front for the purpose of replacing bulbs. Formerly it was necessary for the inspector to carry a large ladder from the nearest dock—a large ladder is kept in each dock for various purposes; but the new ladder, which only weighs a few pounds, is now carried by the inspector on his trips.

The new ladder, which the inspector carries without trouble, is provided at one end with a hook that is hooked into the scroll work at the top of the lamppost. The other end is strapped to the base of the post about 3 feet above the level of the ground. This eliminates the possibility of a motor truck striking the ladder and pulling the inspector from the lofty post.—By *C. W. Geiger.*

An Interesting Drainage Culvert Constructed Through a High Railway Fill

DRAINAGE operations in Yakima County, Washington, are mainly for the purpose of reclaiming waterlogged land and areas on which alkali has accumulated through the lack of proper under-drainage or outlets for waste irrigation water. In the work of installing a drainage outlet for 10,000 acres of land in the county a culvert 100 feet in length in a 41-foot cut under the Union Pacific Railway, near Granger, had to be constructed.

In constructing the culvert piles of 65-foot length were driven through the center portion of the fill in order to reduce vibration from passing trains and protect the construction work itself. As the excavation progressed sheeting was placed behind the piles and cribs were constructed on either side. Material was removed by shoveling into steel dump cars which were run on a track to the end of the cut where the boom of a dragline excavator raised them and dumped the contents on the right-of-way.

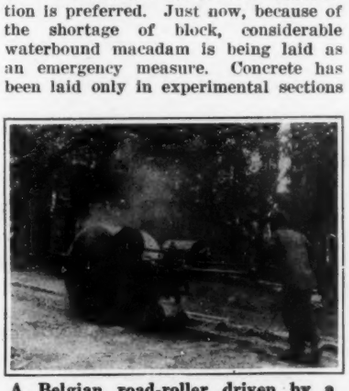
Lagging was hand-driven to the lower lift, where volcanic ash, which is practically quicksand, was encountered. Water jet was used here and lagging was put into place by hand. Double lagging was necessary in order to prevent the water diverted through an old culvert from breaking through into the excavated area. The old culvert was 25 feet from the center line and 6 feet above the bottom of the culvert under construction. During the excavation of the last 8 feet a 5-inch and a 4-inch pump operated by electricity were used in diverting the water.

In the soft earth in the bottom of the trench gravel was placed considerably deep and on top of this a foot of concrete was laid. Concrete pipe, reinforced, and 4 feet in diameter, was placed on the concrete floor and the joints were cemented. Afterward a cradle of concrete was formed around the pipe where it lay.

The Miniature Road Rollers of Belgium

BELGIUM is beginning to feel on her highways the strain of the motor truck. The roads on her national system are almost entirely of stone block laid on sand and sand-jointed. On account of the heavier traffic, when these roads are renewed concrete foundations are generally used and the joints are grouted. The older type of road had a life of from 15 to 20 years.

Some tar-macadam has been used, but on the whole stone-block construction is preferred. Just now, because of the shortage of block, considerable waterbound macadam is being laid as an emergency measure. Concrete has been laid only in experimental sections



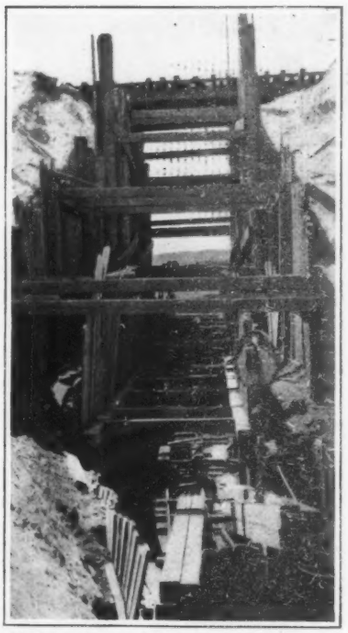
A Belgian road-roller driven by a gasoline engine

and conclusions regarding it have, apparently, not been drawn. For stone block, porphyry is preferred, except on grades where a hard sandstone, called *grès*, is used. The latter is gritty and gives a better foothold than porphyry.

The accompanying illustration, for which we are indebted to *Engineering News-Record*, shows a small road roller employed on Belgium highways. This machine is driven by a gasoline engine on the shaft inside the roller, and is steered by the smaller roller. The operator walks at the rear, with his hands on the control members at the end of a shaft.

Impact Tests to Determine Highway Wear

THE Bureau of Public Roads of the Department of Agriculture has undertaken an important series of impact tests which are expected to establish in what degree motor truck traffic wears highways. These will continue over a considerable period of time. Statement is made that preliminary road impact tests indicate that the impact pressure exerted by a power truck in motion is about six times greater than that of a truck at rest.

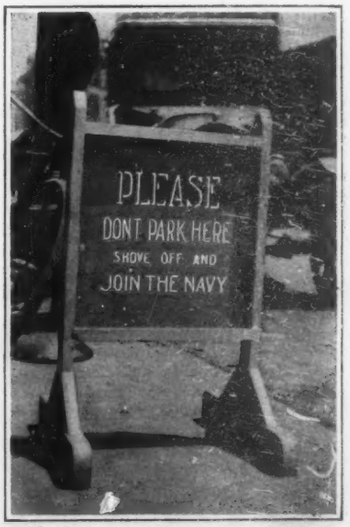


Looking through the excavation made for a draining culvert

The tests were conducted with a class B Government truck loaded up to 5 tons, running up to 15 miles an hour and allowed to fall from varying heights on the impact measuring apparatus. These tests will be continued with trucks ranging from the lightest weight to the heaviest until complete data is obtained. The question of the relative impact exerted by trucks with solid versus giant pneumatic tires will also be investigated.

A New Way of Advertising the Navy

WOODEN tablets, painted navy blue, bearing the words, "Please don't park here. Shove off and join the navy," are now placing the iron "No Parking" shields issued formerly by the police department at Minneapolis, Minn. These signs are installed at the "no parking" zones along the sidewalk in front of certain buildings. The same colored tablet, fastened to a post, is used for a lawn sign on Government plots. This latter reads: "Please keep off the grass. If you want to roam, join the navy."—By *H. Lindquist.*

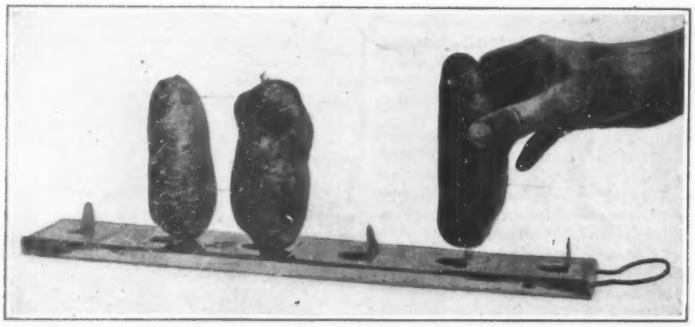


Minneapolis has found a new "no-parking" sign and Navy recruiting appeal combined

XUM

Inventions New and Interesting

A Department Devoted to Pioneer Work in the Arts



Standing the potatoes on end saves considerable space in the oven when space is at a premium

An Idea That Saves Oven Space

IT is economy to have an oven dinner occasionally. And the potato baker shown in the above illustration takes up less oven space by baking the potatoes in a perpendicular position. The tin baker holds six fair-sized potatoes, all of them being removed at one time and without burning the hands.

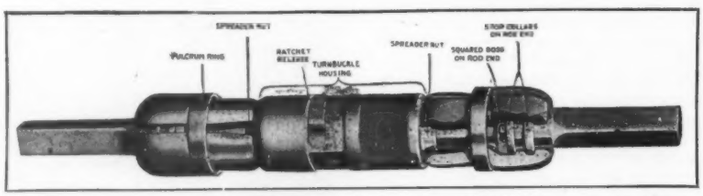
A Step Forward in Coupling Drilling Rods

OWING to the unreliability and great loss of time involved in present practice, the joining of threaded male and female rod-ends has been a source of continuous annoyance to drillers and the men operating deep-well pumps.

However, by means of the newly-invented device herewith depicted a tight joint of sucker-rods or drilling poles can, within a few seconds, be accomplished in a reliable and more efficient manner than by the former way of screwing them together. And the latter was no easy task, considering that the lengths of rods and poles vary from 20 to 25 feet. This new rod coupling is constructed on practically the same principle as the hose coupling described in the SCIENTIFIC AMERICAN of June 5, 1920.

As may be seen from studying the illustration, a quick, tight and reliable joint can easily be obtained by allowing the squared boss-ends of the rods to slip into the squared sockets of the connecting shaft of the coupling, and by applying an ordinary wrench to the hexagonal recess of the turnbuckle-housing. The rods are, therefore, and without being turned, drawn together until their stop-collars are firmly seated on the stop-collars of the connecting shaft. The unscrewing of the turnbuckle during pumping or drilling operations is made impossible by means of a small ratchet inside of the housing, preventing same from turning backward, unless purposely released.

By the use of this new system of coupling invented by John Arthur Weis of New York City, rods can be lowered in a bore-hole or pulled in less than one-third of the time formerly needed, wherefore this style of coupling will be of greatest interest wherever poles or rods are extensively used, especially in deep well drilling and pumping.



The new coupler for drill rods and sucker rods, partly broken away to show the coupling members

A slot in this tool permits of running oil between the spring leaves

A Handy Spring Oiler

THE oiler illustrated at the left has recently been patented. It is a most ingenious tool and will be found quite handy when working on an automobile. It is a combination oiler and wrench, and when used for the former purpose it is driven in between the leaves of the spring, preferably in the center. Its end is tapered, thus making insertion easy. Oil when applied runs down the grooved portion which is carried back about three inches from the tapered end, as shown.

Moving a Bungalow by Motor Truck

WHEN the average citizen moves his home he hires a truck or a cart or wagon and several experienced able-bodied furniture manglers to do packing and loading and unloading and setting up, and confidently expects that at least half of his property will be serviceable when he is "settled." This is because the average house is owned by others or is too weighty or bulky to be taken along with the furniture.

But seemingly the ideal removal was made a short time since by a San Diego, Cal., resident, who was dissatisfied with his location. He bought a property four miles distant and because his bungalow suited him perfectly he wanted to set this up on the new lot. Removing it appeared difficult, but an enterprising truckman decided it was a practical undertaking. The building was mounted on wheels and with a big truck it was hauled over the road in six hours. From this it is evident that the bungalow has advantages that largely compensate its disadvantages when one wishes to move from one locality to another.

A New Kink in Olive Forks

ONE of the simplest olive forks yet brought to our attention is that illustrated at the right. On the end of a long handle are two prongs, one of which is straight while the other is slightly curved. By piercing an olive with the straight point and giving the handle a slight twist, the curved prong catches the olive and prevents it from falling back into the bottle.

Taking the Dirt and Trouble Out of Small Power Plants

A SELF-CONTAINED electric lighting plant that has the appearance of a piece of steel furniture, together with a highly-finished cabinet to house the battery, the combination adding to the appearance of any home, yacht, or wherever it may be placed, has just been brought out. It puts to shame the unsightly, oil-bespattered engines and open, dust-littered battery cells that are so common.

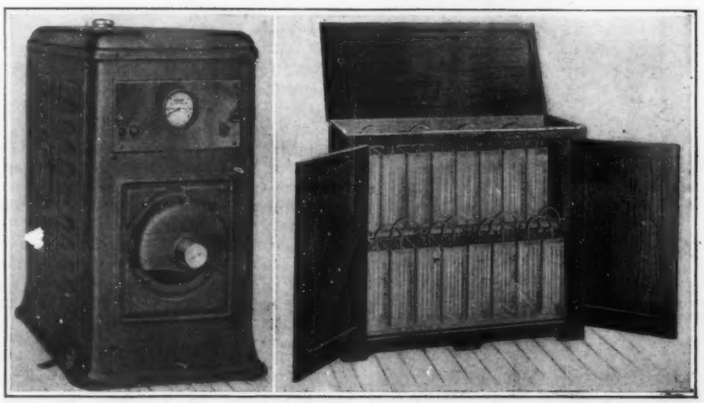
But, in addition to the appearance of the new electric unit, it employs what is undoubtedly the most handy feature ever used in a lighting plant. This is called the "Control Case"—a drawer which contains all of the vital electrical mechanism, instead of the usual multiplicity of meters, fuses, switches, etc., mounted on an open board. This "drawer" slides in and out the same as a drawer in any table or desk. If any trouble occurs one simply pulls out this drawer and slips another in its place, and the trouble is ended.

A jab at the olive followed by a slight twist does the trick

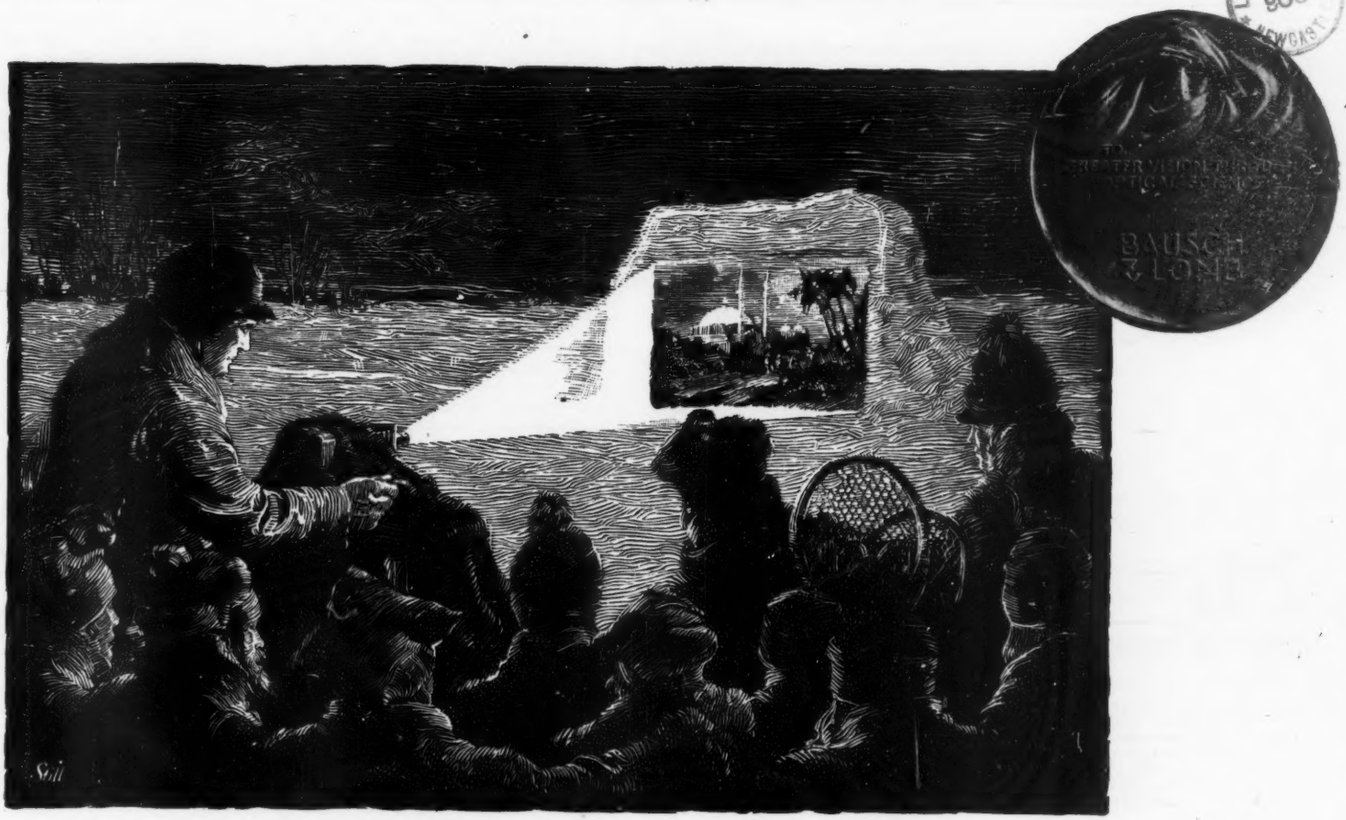
Heating Dwelling Rooms with Acetylene

WE learn from the Bulletin of the Swiss Acetylene Society that the heating of dwelling houses by means of acetylene instead of coal is being strongly urged because of its great economic advantages. Enthusiasts, indeed, declare that we are about to enter upon a new period of domestic heating. Less service is required to handle the furnace and the time required for heating the building is less. In the Palace Hotel at Lausanne, a central heating system making use of acetylene has been in operation for several months, and is said to give great satisfaction. The building consists of a block of five houses, and to secure a temperature of 10° C. or 50° F., 400,000 calories are required, which requires the combustion in the middle of winter of 800 km. of coal per day. In mild winter weather this hotel can be kept very comfortable by the daily consumption of from 100 to 200 km. of carbide.

The acetylene is produced in a stationary acetylene apparatus mixed with air, and burned in a coil system. The entire hot water system to serve the five houses can be heated in 20 minutes to a temperature of from 70 to 80° C. or 158 to 176° F. Satisfactory precautions for entire safety of operation are of course fully guaranteed.



Two cabinets of steel contain the engine, generator, and storage battery, thus eliminating dirt and trouble



Opening the Shortest Pathway to the Brain

IT is the prolonged dusk of Arctic night one hundred miles above the Circle—the thermometer far below zero and snow piled mountains high. A crowd of unlearned but eager Lapps, too numerous for the small mission chapel nearby, are assembled in the open air on skis and snowshoes—their eyes centered on a crudely erected screen of snow.

Across this screen, as white as Nature can make it, flashes a succession of vivid pictures—Japan, China, Korea, tropical India, all imaged on that Arctic background—pictures of climes and peoples that benighted audience had never dreamed of. And the source? A simple but efficient little stereopticon, the Balopticon, mounted on a rough table in the snow and covered with a heavy, protecting blanket, that its lenses may not break in the frigid atmosphere.

This true incident is perhaps unusual, but no more significant than countless other instances of Balopticon service. Optical projection has broken down the travel barriers to a knowledge of the earth. Photography and projection co-operating bring the world to our feet, for whatever can be photographed anywhere can be projected in life-like reproductions anywhere else.

And so in church and mission, school and college, lecture hall and home, wherever people of any race or creed gather together, the Balopticon has made its enlightening way, adding to the sum total of human knowledge as no other agency can. For the eye is the gateway of the shortest nerve path to the brain. What the eye sees, the brain comprehends quickest and remembers longest.

In its development of the Balopticon to represent the most complete and efficient line of projection apparatus obtainable, the Bausch & Lomb Optical Company has but further enriched its seventy years of service—of supplying practically every form of lens or optical instrument that humanity needs in its search for truth and knowledge.

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Sawtooth Correctly Used

THE sawtooth roof is no cure-all for bad light and ventilation: there are right and wrong ways to use it.

The *wrong* way is over *any* low, very wide building needing much light and air. A machine shop thus treated is a lost opportunity in design.

The *right* way is an *auxiliary* feature, on a building narrow enough and high enough to permit light from the sides to reach past the centre. The building shown below illustrates this. Even when it is filled with machinery, there will be no hampering shadows, no objectionable contrast of light and shade, to make clear vision difficult.

The sawtooth is rarely the *best* roof for any purpose; but it is far better than a solid roof, and its exclusion of all direct sunlight is an advantage for certain limited uses.

As manufacturers of **LUPTON STEEL SASH PRODUCTS**, we are glad to advise our customers on the best arrangement of building and sash to get maximum results. No charge is made for this service.

Write for leaflet, "The Case of the Sawtooth Roof." It tells *where* and *how* to use the sawtooth for good results, and what to use where the sawtooth's limitations render it unsuitable.

"Today—the Sash makes the Factory"

Westinghouse Electric & Mfg. Co., East Springfield, Mass., Machine Shop. Bernard H. Prack, Archt. & Eng'r. Building is 100 x 1000 feet, with walls 17½ ft. high. Thirty sawteeth in roof, each 40 ft. long. Lupton Factory Sash and Pond Continuous Sash used throughout.

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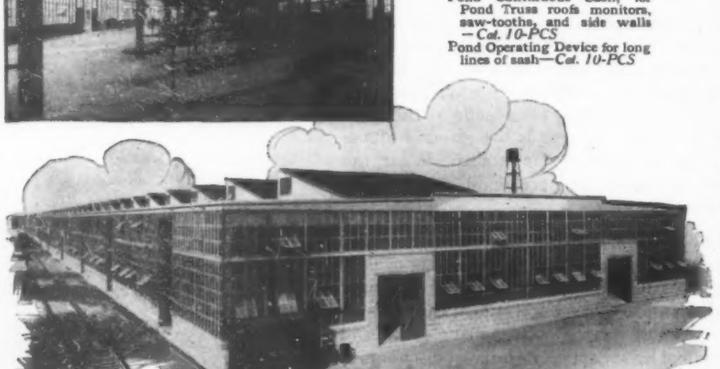
Pond Operating Device for long lines of sash—*Cat. 10-PCS*



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Our Lagging Gold Production

(*Continued from page 628*)

closing down. The principal causes of decline in gold mining in this country are the high wages, the decreased efficiency of that labor and the great increase in the cost of supplies. Since the outbreak of the war, prices of all commodities have increased greatly except that of gold, which as the standard of value is fixed at $20.67 per ounce. In other lines of activity where the cost of production increased the manufacturer could raise the price to be paid for his particular product to meet the excess cost, but the miner could only obtain $20.67 for an ounce of gold, even though the cost of producing it had doubled. Under the circumstances many mines have been compelled to close and await more favorable conditions. Those mines that have continued operations have been able to do so only by practicing the most rigid economies and by the curtailment of development work. The increased freight rates and car shortage have seriously interfered with the production of those mines compelled to transport their ore by railroad to distant smelters, and in the case of the dredging companies in California and Oregon the shortage of electric power has been so great that they were compelled to suspend operations entirely for several months in the summer or "dry" season, or else to operate under a decreased schedule, which raised their operating costs to a point where it was no longer possible to mine at a profit. Many dredges have been started in districts where the successful operation of the boat depends primarily on low running costs, and a large yardage, for there is only a certain value in each cubic yard of gravel and it must be extracted at a cost below that value if a loss is not to be sustained. The adding of a cent or two to the cost of handling a cubic yard of gravel often wipes out the margin of profit. Many of the smaller dredging companies found it necessary to shut down their operations, but the big ones, running a number of boats, find it so necessary to keep their trained men together that they cannot afford to suspend, and these companies have continued producing gold at the expense of greatly diminished profits.

To meet the situation confronting the gold miners in the United States a number of suggestions have been made for protecting them against adverse economic conditions. It has been suggested that a bonus per ounce be given to gold producers until such time as economic conditions will return to normal. The American Mining Congress and many other public organizations have adopted resolutions calling upon the Government to pass some legislation favorable to the mining industry, but to date these plans have not passed beyond the talking stage.

In connection with the suggested bonus on gold it is interesting to note that the same subject is being brought to the attention of the authorities in South Africa and Australia, and is now under discussion in England. The British Government has appointed a committee of experts to make a sweeping inquiry into the conditions at gold mines and to suggest possible measures of relief. Especial attention is being given the desirability of granting the demands of the gold producers for a revision of the selling price of their product to compensate for the increased cost of labor and supplies, to means of encouraging the mining of low-grade ores, and of stimulating the production of gold in general. According to a statement issued by the Chairman of the Transvaal Chamber of Mines, out of 46 companies operating in the Transvaal, 6 were running at a loss and 15 were barely paying expenses, and it is said that a large number of the mines on the Rand will have to shut down unless given some relief.

The North Platte Project Today

(*Continued from page 629*)

after the river flows eastward a hundred miles or more to the land just opened for settlement the average elevation in the vicinity is about 4,100 feet above the sea-level. The stream was naturally a turbulent one and subject to enormous fluctuations in flow. At one time, there would be a devastating flood; at another, the old settlers would have difficulty in getting enough water to keep the crops alive. The excess water of the one season, though needed later on, simply went to waste. The lands now under irrigation had a normal value of about $1.25 per acre and served principally as grazing land over which cattle and sheep roamed with their attendant keepers. Now, the irrigated ranches are bought and sold at $150 to $200 per acre, and have a rental value per acre per year of $15 to $25. These are not land-boom values, but prices paid by one experienced settler to another. The sugar beet crop totals about $1,000,000; the potato crop another $1,000,000. Alfalfa attains a value equal to both combined. Wheat, oats, barley and maize are regular standard products. The country is so well-to-do that "automobiles on the country road are so thick that speed laws are unnecessary." It is claimed, in fact, that the agricultural value of these lands is probably as high as that of any other section in the country, with the possible exception of the fruit districts of California, Washington and Oregon. So, then, the cow and sheep country has not been turned into land that is moderately valuable, but into land that is comparable with the best there is.

The North Platte project is a one-river enterprise. That is, it involves only a single general watershed. Naturally, minor rivers and streams tributary to the main river are to be included. The irrigated district lies partly in eastern Wyoming and partly in Nebraska. Near the boundry line between the two States, a subsidiary dam was placed. This structure is a diversion dam. The result has been a connection with two of the largest canals in the West. Each is 125 miles long and serves, or will serve, 100,000 acres.

The temperature in the various parts of the irrigated district naturally varies because of a difference of conditions. However, in the Fort Laramie region at an altitude of three-quarters of a mile, the mercury goes down to 30 below and up to 104 above zero, F. The irrigation season runs for six months, beginning April 1. But canals may have to be operated in winter time for other reasons. Thus, the Lingle Power Plant in Wyoming depends upon Platte water for its operation, and the City of Torrington depends, in turn, more or less upon this plant for lighting current. Naturally, such demands require winter operation of canals. The daily average of current supplied, in winter, seems to be around 700 kw-hrs.

How Hard Is a Rock?

(*Continued from page 629*)

The grip containing the specimen is then removed, brushed free from dust, and weighed. By the use of small metal washers, one or more of which may be slipped over the projecting rod of the grip, the initial weight is adjusted to exactly 1,250 grams. Forthwith, the grip is replaced in the same position as previously and the machine given 1,000 revolutions, 30 to the minute. The material is again weighed, the tests being repeated with specimens reversed as a method of ascertaining the average hardness of the two ends. The one-fourth inch opening in the funnel of the hardness machine will consume 18.5 pounds of sand during the test. The coefficient of hardness for varying types of rock will range from 19.7 for the hardest specimens of quartzite to 0 for extremely soft limestones and sandstones.

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Why the Cliff-Dwellers Vanished

(*Continued from page 630*)

change of work. Under primitive conditions all of this was wanting and it is, therefore, a safe assumption that the disastrous consequences of dust inhalation have been one of the most important contributory causes of an excessive death rate, leading ultimately to race extinction.

Without enlarging for the present purpose upon further details, it is sufficient to have emphasized one of the possible additional reasons, not heretofore advanced, why this ancient civilization should have come to an end. How large that population was is now, of course, but a matter of mere conjecture. According to Prudden, there is no reason for believing that the number of rooms in any district affords an exact indication of the populousness of the region at any one time, because the present condition of the ruins seems to point to very great differences in age. When the Old North Pueblo of Pecos was discovered by Coronado in 1540, it was described as to contain from 2,000 to 2,500 inhabitants. By 1797 the population had decreased to 89, which by 1838 had been reduced to a remnant of only "a dozen or so." (P. 38, Archaeological Institute of America.) It might be possible by estimates based upon the number of rooms in this ruin to arrive at some conclusion as to the probable density of population at a period when, however, the true cliff-dwellers had probably long been extinct. The South House at Puye, described by Morey, contains 173 rooms, which, assuming four persons to a room, would give about seven hundred inhabitants. But it is impossible today, due to destruction and decadence, to estimate with accuracy the probable number of rooms used for residential purposes, and nothing, of course, is known as to the approximate number of inhabitants.

If there is so much uncertainty as to the number of ancient inhabitants, there is somewhat less doubt as to their bodily proportions. Unfortunately, far from enough has been made of the skeletal remains that have been discovered and over-emphasis has been placed upon cranial measurements, much less important than bodily proportions for really practical purposes. Morey in his report on the "Cannon-ball Ruins in Southwest Colorado" describes three entire skeletons, assigning to the femur a proportion of 27 per cent of the entire length and determining the stature of the three at 5 ft. 2 in., 5 ft. 3 in., and 5 ft. 4 in., respectively; or all under 5 ft 6 in., and while he admits that these values are probably a little low, he remarks that "even discounting the slight shrinkage which invariably takes place between the living body and the skeleton, the heights thus attained are approximately low." This conclusion seems justified in the light of other measurements, all indicating that the average stature of the builders of these structures was "considerably below that of our own race"; and this is true also for the Pueblo, Zuni, and Hopi Indians of today.

Without, therefore, arguing the question as to the probable numbers of the ancient population and the rate of decadence during the historic period as possibly deter-

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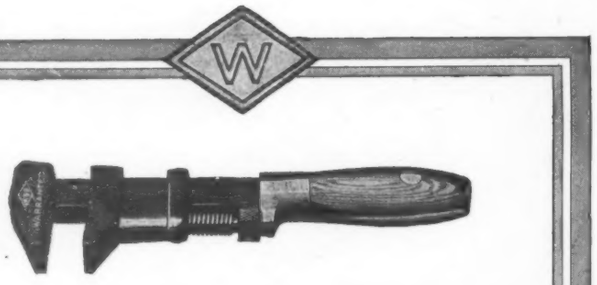

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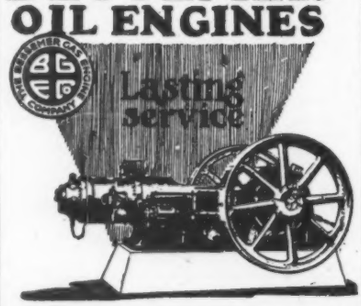

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mined by existing ruins, it would seem that the conclusion is justified by the known facts, that this population was quite extensive, but at the time of its decadence, below average stature, possibly indicative of undernourishment, which, with the indicated continued exposure to health-injurious dust, would lead to the further conclusion that an excessive mortality rate, more probably than any other extraneous cause, gradually led to an excess of deaths over births, and a vanishing population, of which the remnants found shelter and new homes among the Pueblos farther to the south, possibly as far as northern Mexico.

This conclusion, which as far as I know, has not heretofore been advanced, is also supported by another fact of not inconsiderable importance. The extensive and unusual development of the pottery industry among these people also represents a dusty and health-injurious occupation, which under given conditions would be certain to prove detrimental to life and health. The subject is, therefore, one well worth further consideration and it is hoped that these suggestions may at least result in the scientific ascertainment of the nature of the stone materials manipulated by these ancient people and particularly the chemical and microscopical characteristics of the stone work and masonry, typical of the so-called cliff-dwellings, varying widely, of course, according to the geological formation from southern Colorado and Utah to southern New Mexico and Arizona.

Disposing of the Sewage

(*Continued from page 632*)

cance of efficient spraying and delivering the sewage in fine showers to trickle through the interstices of the beds and carry fresh supplies of oxygen to sustain aerobic conditions. The beds, otherwise, are apt to become clogged and ineffective.

When, in 1909, the filter beds of the Mount Vernon Works were ready, repeated trials were made of various sprinkling devices in use elsewhere, especially of the cups used at the Experimental Station of Massachusetts. These latter contrivances gave the best results, but it was not until Mr. Boyd Wilkie, now superintendent, devised a cup with a rolled rim, that nearly perfect results were obtained. This cup of rolled metal, three inches in diameter, one inch deep, with a rolled rim, is socketed on a standard eighteen inches high to receive a stream from a ¾-inch nozzle at an elevation of about five feet. Exhaustive experimental tests (*Engineering News*, March 24, 1910) were made, finally giving 92 per cent efficiency in overlapping areas of spray. The secret of the efficiency of the cup is the rolled rim which spreads the spray evenly, over a greater circumference of area than a cup with a sharp edge, and in finer spray.

When the building of the plant was under discussion and before a final decision was reached, in order to satisfy property owners and residents in its vicinity, the engineers were obliged to devise a ventilating system to carry off noxious odors which, in ignorance of the efficiency of properly constructed filter-beds, the public imagined, would be insufferable.

So, at an unnecessary expense of some thirty thousand dollars, twin towers were erected, supplied with electrically-driven fans to draw off, through a system of drums, the noxious gases from the filter sheds and scatter them in the upper air. Of course, there was no appreciable odor beyond the immediate vicinity of the works to be overcome in any such ridiculous way. The device has never been used. The contractors derived the sole benefit of the extra expenditure. At a distance of a hundred yards from the works, no odor is perceptible.

The grounds about the works have been graded and made into the semblance of quite an attractive park and as there are many shade trees on the surrounding terrace, visitors are not loath to take advantage of a rest on park settees provided for their convenience.

A New American Industry

(*Continued from page 634*)

ingenuity has not been latent in the design of these toys and sales on some recent models have reached enormous figures.

The German toy industry will undoubtedly recover, in a measure, from the paralysis it suffered during the war. But a very different class of toys will have to be sold in this country. There were a few large toy factories in Germany before the war but the backbone of the German toy industry was the individual workman who made toys in his own home, often being assisted by the entire family, marketing his goods through a syndicate. The art of the toy-maker was handed down from father to son through many generations.

The workmanship of these home toy factories is exquisite and it cannot be equaled on a quantity basis. Nor has the American workman the patience to produce such toys at any price. If German labor conditions return to normal, undoubtedly her home toy producers will again be a factor.

As an example, there were recently imported from Germany by a large toy dealer five large models of a great ocean liner. They were perfect in every detail and although they sold for $150 each, they were gone within a few days after being placed on display in New York. The boats could not have been made for that sum in this country.

The situation of our new toy industry is effectively summed up by a New York toy merchant and manufacturer in these words: "Before the war I would have believed it impossible to get along without the German toys. They were the backbone of every toy display. The few American toys were rather shabby and they were just 'fillers' in the line. I tried for years to put a line of American-made mechanical toys on the market without success simply because the toy buyers would not give the line a chance. That was just the trouble. It wasn't that we were not able to make toys as well as anyone else, but that no one would buy them. The war gave us the chance and we have never missed the German toys from our shelves. There will be some toys imported, we may be sure, but the foreign toys will occupy about the same place in our market that the domestic toys used to hold."

The Properties and Uses of Manjak

(*Continued from page 635*)

ular efficacy in keeping such pipes watertight, air-tight, and free from corrosion at the joints, but it also facilitates the work of joining and separating the pipes owing to its lubricating qualities. It has been found much superior to white lead or any other substances previously used for such purposes, and its use results in economy.

The Government of Trinidad is now making use of manjak in painting the under parts of bridges and other structures where protection is required from water. Excellent results have been obtained by using manjak paints and compounds on steel smoke stacks, car trucks, fenders, burrers, and all iron and steel work connected with power-house and car buildings. Their compounds have also been used successfully in the form of insulating varnish on armatures and electrical connections, and on car roofs as a protection from the hot, tropical sun and rain. In general, where a good insulating material is required against heat or electricity, the value of manjak is said to be exceeded only by rubber and glass.

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